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NATIONAL DAM SAFETY PROGRAM. OAK RIDGE RESERVOIR DAM (NJ00014).--ETC(U)
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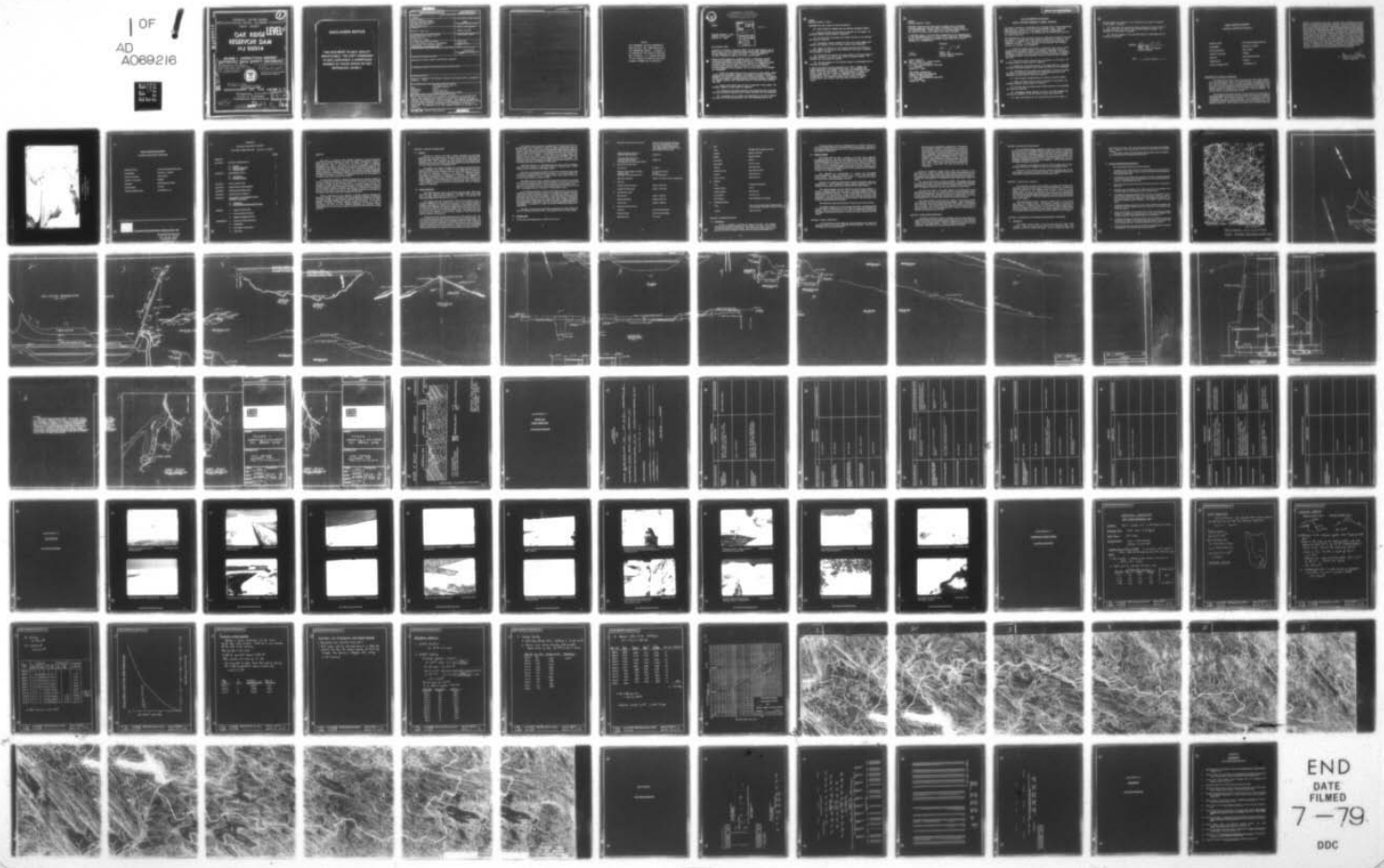

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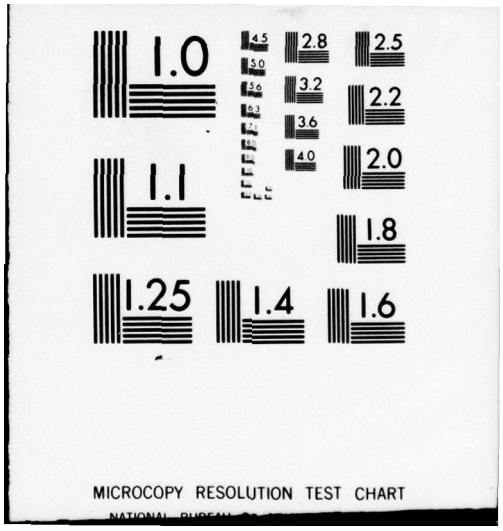
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PASSAIC RIVER BASIN
PEQUANNOCK RIVER, MORRIS COUNTY
NEW JERSEY

OAK RIDGE RESERVOIR DAM NJ 00014

LEVEL II

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM.

(6) Oak Ridge Reservoir Dam (NJ 00014).
Passaic River Basin. Pequannock River,
Morris County, New Jersey.
Phase I Inspection Report.

(9) Final rept.,

Approved for public release;
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(10) Dennis J. Leary

(15) DACW61-78-C-0124

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

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Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

	Oak Ridge Reservoir Dam, N.J.
Dams	Structural Analysis
Embankments	Safety
Foundation	Visual Inspection
Spillway	National Dam Inspection Act Report

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE – 2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-D

7 MAY 1979

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Oak Ridge Reservoir Dam in Morris County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Oak Ridge Reservoir Dam, initially listed as a high hazard potential structure but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition and the spillway is considered adequate. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. Within six months from the date of approval of this report, engineering studies and analyses should be performed to determine the dam's embankment and foundation condition and structural stability. This should include test borings to determine material properties relative to stability. Any remedial measures found necessary should be initiated within calendar year 1980.

b. Within three months from the date of approval of this report, the following remedial actions should be completed:

(1) Completely plug animal burrows in the downstream face of the dam and provide protection against future animal burrowing into the embankment.

(2) Investigate the wet spongy area downstream of the dam to confirm the source of the spring reported to be in the downstream area of the

embankment and take required corrective measures.

(3) Debris should be removed from the spillway discharge channel.

c. Within six months from the date of approval of this report, the following remedial actions should be completed:

(1) The open joint and spalled and cracked concrete on the spillway weir should be repaired.

(2) Investigate leakage through the rock at the outlet chamber and evaluate the stability of the rock under extreme flood conditions.

(3) Raise the elevation of the platform from which the valves in the gate chamber are operated so that operation of the gates is possible if the chamber is flooded.

(4) Investigate the present and future effects of the root system of the trees located at the right of the spillway discharge channel. If necessary the trees should be removed.

(5) The left abutment of the spillway should be investigated and if necessary strengthened.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman James J. Courter of the Thirteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

NAPEN-D
Honorable Brendan T. Byrne

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

OAK RIDGE RESERVOIR DAM (NJ00014)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 30 November and 6 December 1978 by Langan Engineering Associates, Inc., under contract to the State of New Jersey. The state, under agreement with the U. S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Oak Ridge Reservoir Dam, initially listed as a high hazard potential structure but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition and the spillway is considered adequate. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. Within six months from the date of approval of this report, engineering studies and analyses should be performed to determine the dam's embankment and foundation condition and structural stability. This should include test borings to determine material properties relative to stability. Any remedial measures found necessary should be initiated within calendar year 1980.

b. Within three months from the date of approval of this report, the following remedial actions should be completed:

(1) Completely plug animal burrows in the downstream face of the dam and provide protection against future animal burrowing into the embankment.

(2) Investigate the wet spongy area downstream of the dam to confirm the source of the spring reported to be in the downstream area of the embankment and take required corrective measures.

(3) Debris should be removed from the spillway discharge channel.

c. Within six months from the date of approval of this report, the following remedial actions should be completed:

(1) The open joint and spalled and cracked concrete on the spillway weir should be repaired.

(2) Investigate leakage through the rock at the outlet chamber and evaluate the stability of the rock under extreme flood conditions.

(3) Raise the elevation of the platform from which the valves in

the gate chamber are operated so that operation of the gates is possible if the chamber is flooded.

(4) Investigate the present and future effects of the root system of the trees located at the right of the spillway discharge channel. If necessary the trees should be removed.

(5) The left abutment of the spillway should be investigated and if necessary strengthened.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 7 May 1975

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NAME OF DAM:	OAK RIDGE RESERVOIR DAM
ID NUMBER:	FED ID No. NJ00014
STATE LOCATED:	NEW JERSEY
COUNTY LOCATED:	MORRIS
STREAM:	PEQUANNOCK RIVER
RIVER BASIN:	PASSAIC
DATE OF INSPECTION:	NOVEMBER 1978

ASSESSMENT OF GENERAL CONDITIONS

Oak Ridge Reservoir Dam is over 60 years old and in fair overall condition. There are animal burrow holes in the downstream slope. The spillway concrete has cracked and spalled. There is a large wet spongy area downstream of the dam. This area may be fed from a spring reported to be in the foundation rock. Leakage is occurring through the rock on both sides of the outlet chamber. The spillway capacity as determined by CE screening criteria is adequate. We estimate the dam can adequately pass the PMF.

We recommend the animal burrows in the downstream face of the dam be completely plugged and protection provided against future animal burrowing into the embankment. This should be done soon. The wet spongy area should be investigated, the source of spring reported to be in downstream area of the embankment should be confirmed and required corrective measures taken. This should be done soon. Debris should be removed from the spillway discharge

channel. This should be done soon. The open joints and spalled and cracked concrete on the spillway weir should be repaired. This should be done in the near future. Investigate the engineering properties of the dam and foundation materials by means of borings and tests. This information should be used to evaluate and confirm our assumptions of the degree of stability of the dam under different stress conditions. This should be done in the near future. Investigate leakage through the rock at the outlet chamber and evaluate the stability of the rock under extreme flood conditions. This should be done in the near future. Raise the elevation of the platform from which the valves in the gate chamber are operated so that operation of the gates is possible if the chamber is flooded. This should be done in the near future. Investigate the present and future effects of the root system of the trees located at the right of the spillway discharge channel. If necessary the trees should be removed. This should be done in the near future. The left abutment of the spillway should be investigated, and if necessary strengthened. This should also be done in the near future.

Dennis J. Leary

Dennis J. Leary, P.E.

OVERVIEW

OAK RIDGE RESERVOIR DAM

1 DECEMBER 1978

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NAME OF DAM:	OAK RIDGE RESERVOIR DAM
ID NUMBER:	FED ID No. NJ00014
STATE LOCATED:	NEW JERSEY
COUNTY LOCATED:	MORRIS
STREAM:	PEQUANNOCK RIVER
RIVER BASIN:	PASSAIC
DATE OF INSPECTION:	NOVEMBER 1978

LANGAN ENGINEERING ASSOCIATES, INC.

Consulting Civil Engineers
990 CLIFTON AVENUE
CLIFTON, NEW JERSEY
201-473-3366

CONTENTS

NATIONAL DAM SAFETY REPORT

OAK RIDGE RESERVOIR DAM FED ID No. NJ00014

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

SECTION 1 PROJECT INFORMATION

1.1 General

Authority to perform the Phase I Safety Inspection of Oak Ridge Reservoir Dam was received from the State of New Jersey, Department of Environmental Protection, Division of Water Resources by letter dated 20 November 1978. This Authority was given pursuant to the National Dam Inspection Act, Public Law 92-367 and by agreement between the State and the U.S. Army Engineer District, Philadelphia, Penn.

The purpose of the Phase I Investigation is to develop an assessment of the general conditions with respect to safety of Oak Ridge Reservoir Dam and appurtenances based upon available data and visual inspection, and determine any need for emergency measures and conclude if additional studies, investigations and analyses are necessary and warranted. The assessment is made using screening criteria established in Recommended Guidelines for Safety Inspection of Dams prepared by the Department of Army, Office of the Chief of Engineers. It is not the purpose of the inspection report to imply that a dam meeting or failing to meet the screening criteria, is per se, certainly adequate or inadequate.

1.2 Project Description

Oak Ridge Reservoir Dam is over 60years old, 60-ft high, 1275-ft long earth dam with a concrete core and spillway. The spillway crest is 375-ft long and is an ogee shaped over-fall with an 11 ft drop. The upstream and downstream slopes of the dam are 2 hor to 1 vert.

The original dam was constructed in 1914 and was raised in 1917 to provide an additional 10 ft of water in the reservoir. Very little information is available concerning the design and construction of the original structure. Drawings dated 1892 show the top of the original dam at el 842.5 and the top of the core wall at el 838.4. The maximum height of core wall is about 75 ft. It is 5 ft thick at the top and 8 ft thick below the dam. Drawings indicate the bottom and left abutment of the wall are founded on rock and the right abutment appears to be on gravel.

Raising of the dam included widening the dam on the upstream side. This was done during the dry season when the reservoir was practically empty. The work included raising the core-wall by building an additional 10 feet thereon and re-enforcing the earth embankment on both sides of the core-wall; raising the spillway by building an entire new spillway on the upstream side of the original spillway; raising the outlet chamber 10 feet to conform to the new flowline; and connecting the chamber as raised with the new spillway and raised earth dam.

The upstream side of the dam is riprapped and the downstream surface is grassed and has a 15-ft wide berm. There is a masonry chamber built into rock for the outlet works. There are four 42-in-dia outlet pipes passing through the chamber. They originally had reducers and 30-in gate valves that were operated from a platform at the bottom of the chamber with 42-in flap valves at the reservoir face of the chamber. In 1953 two of the 30-in gate valves were replaced with 18-in roto valves and the flap valves were overhauled. These two valves are used regularly to release required flows of 10 to 45 gpm. The discharge channel is a rock gorge at the right of the spillway leading to a stony stream bed that passes under Berkshire Valley Road.

Operating procedures for Oak Ridge Reservoir Dam consist of releasing water from the reservoir to maintain a balance of required water in other reservoirs within the Newark water supply system.

The dam is located south of Route 23 and north of Berkshire Valley Road in Jefferson Township, Morris County, New Jersey. It is at north latitude 41° 2.4' and west longitude 74° 30.7'. A regional vicinity map is given in Fig 1 and essential project features are given in Fig 2.

Oak Ridge Reservoir Dam is classifed as being "Intermediate" on the basis of its maximum reservoir storage volume of 15000 ac-ft, which is more than 1,000 ac-ft, but less than 50,000 ac-ft. It is also classified as "Intermediate" on the basis of its total height of 60 feet, which is greater than 40 feet and less than 100 feet. Accordingly, the dam is classified as "Intermediate" in size.

In the National Inventory of Dams, Oak Ridge Reservoir Dam has been classified as having "High Hazard Potential" on the basis that failure of the dam would cause excessive property damage to residences downstream, and could potentially cause more than a few deaths. Visual inspection of the downstream area shows that breach of the dam would cause little damage to residences which are located on high ground but could be hazardous to people utilizing the low lying Berkshire Valley Road. This road is a heavily traveled secondary road. Accordingly, it is proposed to change the Hazard Classification Potential to "Significant."

The dam is owned by the City of Newark, Department of Public Works 787 Broad St., Newark, New Jersey 07102. The purpose of the dam is water supply.

1.3 Pertinent Data

a. At dam site, the drainage area is 17,308 acres (27 sq mi)

	Maximum known flood at dam site:	Flood of 9,10,11 October 1903 gave 2.4 ft over old spillway which was 350 ft long. Runoff during peak of 1903 flood equaled 145 cfs per sq mi. New spillway is 375 ft long.
	Ungated spillway capacity at maximum pool elevation:	27,225 cfs
	Total discharge capacity at maximum pool elevation: (including four low level outlet pipes)	28,697 cfs
b.	Elevation (ft above MSL)	
	Top of Dam:	El. 852.5
	Maximum pool-design surcharge:	El. 851.5 (estimated)
	Spillway crest:	El. 845.5
	Streambed at centerline of dam:	El. 790. (estimated)
	Maximum tailwater:	Approx. El. 792.5 at time of inspection.
c.	Reservoir	
	Length of Maximum pool:	Approx. 13800 feet
	Length of normal pool:	Approx. 13700 feet
d.	Storage (acre-feet)	
	Normal pool:	Approx. 12000 AF
	Design surcharge:	Approx. 14550 AF
	Top of dam:	Approx. 15000 AF
e.	Reservoir Surface (acres)	
	Top dam:	432 Acres (estimated)
	Maximum pool:	432 Acres (estimated)
	Spillway crest:	421 Acres

f. Dam

Type:	Earthfill with concrete core wall
Length:	Approx. 1275 feet
Height:	Approx. 60 feet
Top width:	20 feet
Side Slopes:	2 hor to 1 vert
Zoning:	None observed
Impervious core:	Concrete core wall
Cutoff:	None observed
Grout curtain:	None observed

g. Spillway

Type:	Overfall; ogee shaped
Length of Weir:	375 ft
Crest elevation:	Elev 845.5 ft
U/S channel:	Cut into rock
D/S channel:	Apron leading to rock gorge

h. Regulating Outlets

Type:	Four 42-in-dia outlet pipes with flap valves Two 30-in gate valves and two18-in cone valve
Length:	Approx. 34 feet

SECTION 2 ENGINEERING DATA

2.1 Introduction

No data is available concerning the design of the dam. The available information concerning construction of the raising of the dam in 1917 consists of written specifications and drawings. These data indicate good judgment and practice was used with respect to the standard of practice prevailing in 1917.

The dam operation consists of releasing water to maintain a balance of water in the other reservoirs to the Newark Water Supply system. Operation is an on-going balancing process where 10 to 45 mgd are released during most of the months in recent years.

2.2 Regional Geology

Oak Ridge Reservoir Dam is located in the New Jersey Highlands physiographic province. The New Jersey Highlands extend across the State in a northeast/southwest direction from the border of New York to the Delaware River and includes the northwest portions of Hunterdon, Passaic, and Morris Counties and the southeastern parts of Warren and Sussex Counties. This province is part of the New England Physiographic Province and lies between the Appalachian Ridge and Valley Province to the northwest and the Piedmont Province to the southeast, See Fig 3.

The Highlands are characterized by rounded and flat-topped northeast/southwest ridges and mountains up to 1,400 ft high separated by narrow valleys. The orientation of the valleys is usually, but not always controlled by the underlying geologic structure.

Bedrock of the region is predominently Precambrian gneisses, schists, and metasediments. Some sedimentary strata, typically sandstones, shales and conglomer ate have been infolded and infaulted into the valley bottoms.

The regional geologic structure reflects the very old age of bedrock. A number of regional faults cross the area in a northeast southwest direction, including the Ramapo Fault; the more than 30 mile long fault/scarp forms the eastern border of the province. Faults control many of the river valley orientations. The relatively uniform slope of the mountain elevations, from northwest to southeast, is a direct result of the faulting. The entire area is part of the now dissected Schooley Peneplain.

The Pleistocene Age Wisconsin glacier covered all of the dam site area.

The glacier stripped most of the existing overburden and weathered rock and uncovered the numerous hard bedrock knobs and ridges seen throughout the province. Most of the side-slopes in the area are covered with heavy boulder tills (ground moraine),whereas glacial outwash and recent alluvium cover the valleys.

SECTION 3 VISUAL INSPECTION

A visual inspection of Oak Ridge Dam and appurtenances was made on 20 September 1968 by the Newark Municipal Utilities Authority. The results of this inspection are summarized below:

Upstream face is riprapped, no displacement. Downstream face is grassed and has a 15 foot berm with no erosion or animal burrows. Crest of concrete overflow section is level and smooth and has concrete abutments at ends. Upstream slope is riprapped. Downstream channel is paved with large stones chinked with small-aggregate concrete in 1956. No indications of leakage, but reservoir level is well below spillway. Slight spalling of end abutment walls. Also noted was a small spring at west end at bottom of downstream face of dam. The spring is reported to have existed many years and to come from the rock and not from the embankment.

During our inspection, animal burrow holes were observed at the downtream toe. There is a relatively large marshy area downstream of the dam. No boils were observed but flow of approximately 40 gpm was observed in a drainage pit at the edge of the marshy area. This may be from the spring reported in the 1968 inspection. The riprapped upstream slope appears in good condition.

The concrete spillway has cracked and spalled. The spillway wing walls also have small cracks. The paved spillway apron has substantially depressed approximately one foot below the top of the bottom section of the spillway wall. The original construction may have been performed in this manner.

The 18-in cone valves in the outlet chamber are functional and can be hand operated by one man. It is reported there is no need to operate the 30in gate valves, consequently, they have not been used for about 25 years. The 42-in flap valves have also not been operated for a long period. The valve operating platform is at el 803 which is about 20 ft below the reservoir.

The outlet channel is incised into rock adjacent to the outlet chamber with lessening rock excavation proceeding downstream. Water is leaking from the rock at both sides of the downstream side of the chamber at an estimated rate of 20 gpm. The channel runs under Berkshire Valley Road and into a winding swampy area to the Pequannock River. There is a small amount of debris in the channel north of the road.

SECTION 4 OPERATION PROCEDURES

Operational procedures consist of releasing water from the reservoir in response to direction from the Newark Water Supply offices in Little Falls, New Jersey. This is done to maintain a balance of required water in other reservoirs within the water supply system. Water is released by opening the two 18-in cone valves. These valves are maintained about four times a year.

SECTION 5 HYDRAULIC/HYDROLOGIC

The hydraulic/hydrologic evaluation is based on a Spillway Design Flood (SDF) equal to the full Probable Maximum Flood (PMF) chosen in accordance with the evaluation guidelines for dams classified as Significant Hazard and Intermediate in size. Hydrologic design data for this dam is not available. The PMF has been determined by developing a synthetic hydrograph based on the maximum probable precipitation of 22.1 inches (200 square mile- 24 hour). Hydrologic computations are presented in Appendix 4. The PMF determined for the subject watershed is 19,441 cfs.

The capacity of the spillway is 27,225 cfs which is higher than the SDF. Therefore, the spillway is adequate and there is no overtopping potential.

Drawdown of the reservoir has been evaluated considering that all four outlet pipes are utilized for lowering the lake. Our calculations indicate that the lake level could be lowered 48 ft in approximately 6 days.

SECTION 6 STRUCTURAL STABILITY

No information has been made available concerning the foundation and construction material properties of the dam and appurtenances. Consequently, analytical evaluation of the stability cannot be made. However, it is our opinion based on our site inspection and review of the construction specifications and drawings that the dam and appurtenances have been designed and constructed using good engineering judgment and practice prevailing at the time the work was done. The dam and appurtenances are assumed to be stable under static loading.

Oak Ridge Reservoir Dam is located in Seismic Zone 1 of the Seismic Zone Map of Contiguous States. The degree of stability of the dam and appurtenances is assumed to be within conventional safety margins and to present no hazard from earthquakes. If, however, the Seismic Zone rating is seriously increased in the future, or data becomes available to indicate it may be increased, further study with respect to seismic stability may be necessary.

SECTION 7 ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Assessment

Oak Ridge Reservoir Dam is over 60 years old and in fair overall condition. There are animal burrow holes in the downstream slope. The spillway concrete has cracked and spalled. There is a large wet spongy area

downstream of the dam. This area may be fed from a spring in the foundation rock. Leakage is occurring through the rock on both sides of the outlet chamber.

The spillway capacity as determined by CE screening criteria is adequate. We estimate the dam can adequately pass the PMF.

7.2 Recommendations/Remedial Measures

We recommend the following remedial measures:

1. Completely plug animal burrows in the downstream face of the dam and provide protection against future animal burrowing into the embankment. This should be done soon.

2. Investigate the wet spongy area and confirm the source of spring reported to be in downstream area of the embankment and take required corrective measures. This should be done soon.

3. Debris should be removed from spillway discharge channel. This should be done soon.

4. The open joint and spalled and cracked concrete on the spillway weir should be repaired. This should be done in the near future.

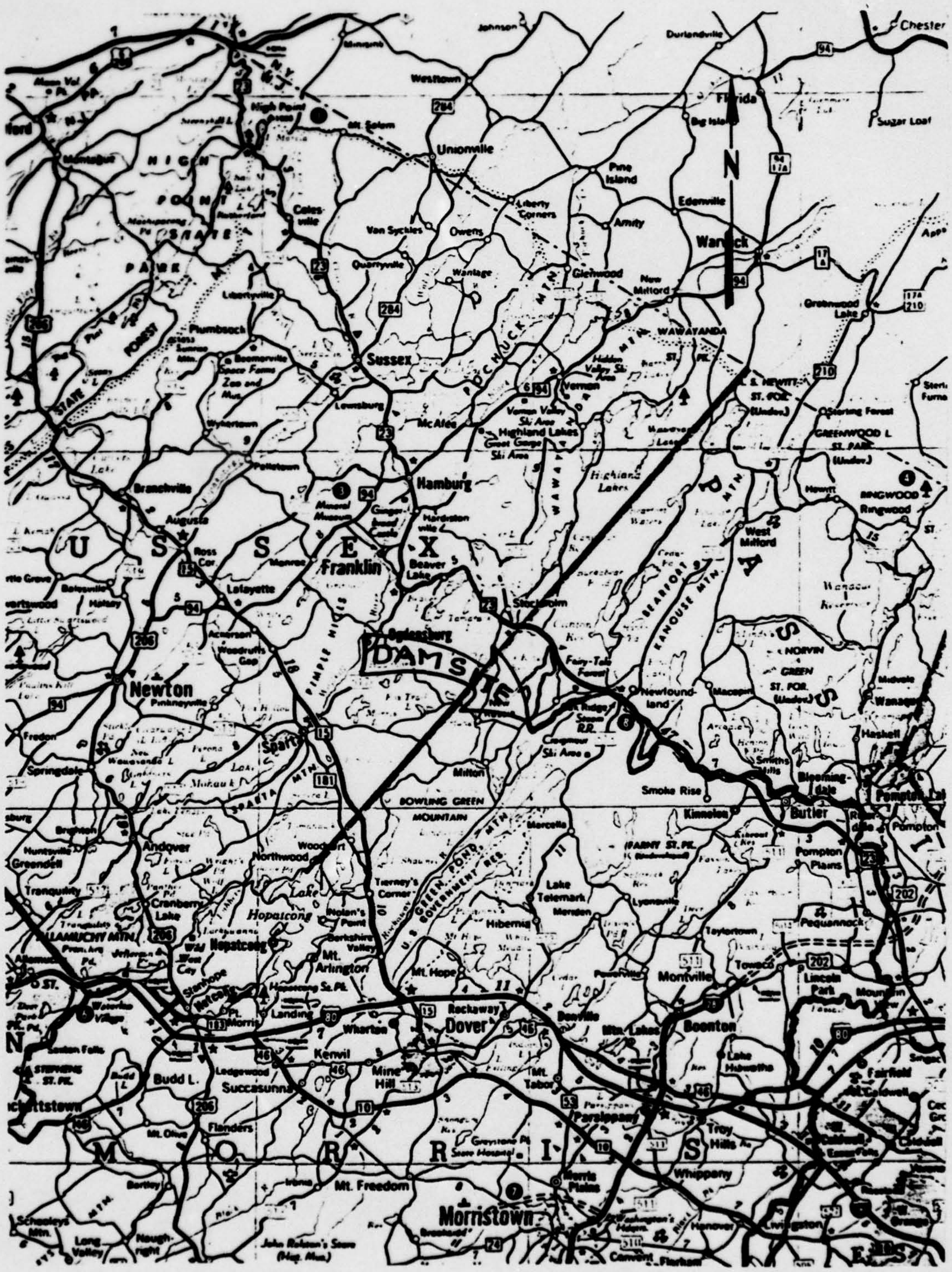
5. Investigate the engineering properties of the dam and foundation materials by means of borings and tests. This information should be used to evaluate and confirm our assumptions of the degree of stability of the dam under different stress conditions. This should be done in the near future.

6. Investigate leakage through the rock at outlet chamber and evaluate the stability of the rock under extreme flood conditions. This should be done in the near future.

7. Raise the elevation of the platform from which the valves in the gate chamber are operated so that operation of the gates is possible if the chamber is flooded. This should be done in the near future.

8. Investigate the present and future effects of the root system of the trees located at the right of the spillway discharge channel. If necessary the trees should be removed. This should be done in the near future.

9. The left abutment of the spillway should be investigated and if necessary strengthened. This should be done in the near future.



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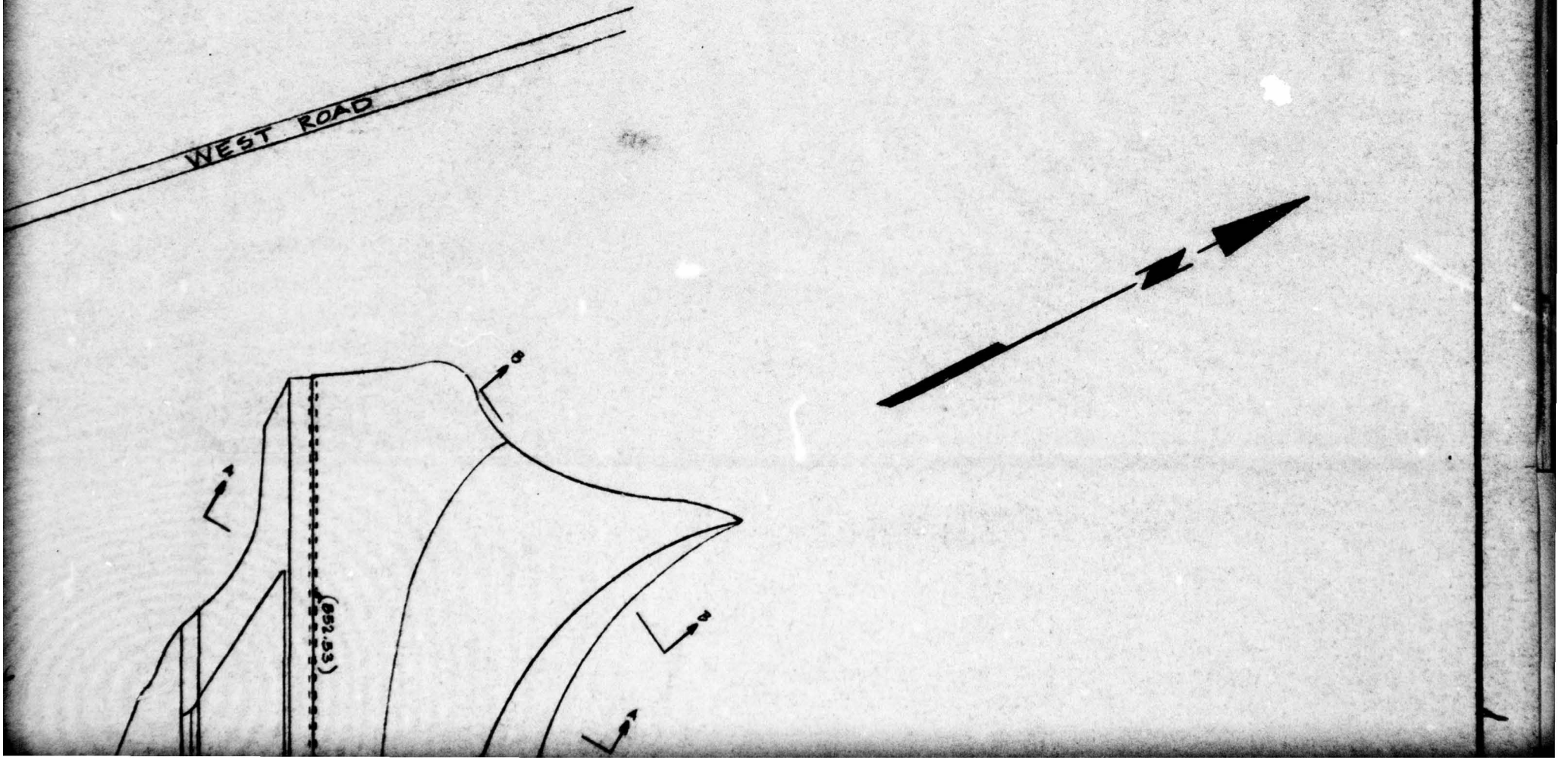
REGIONAL VICINITY MAP
OAK RIDGE RESERVOIR DAM

Fig. 1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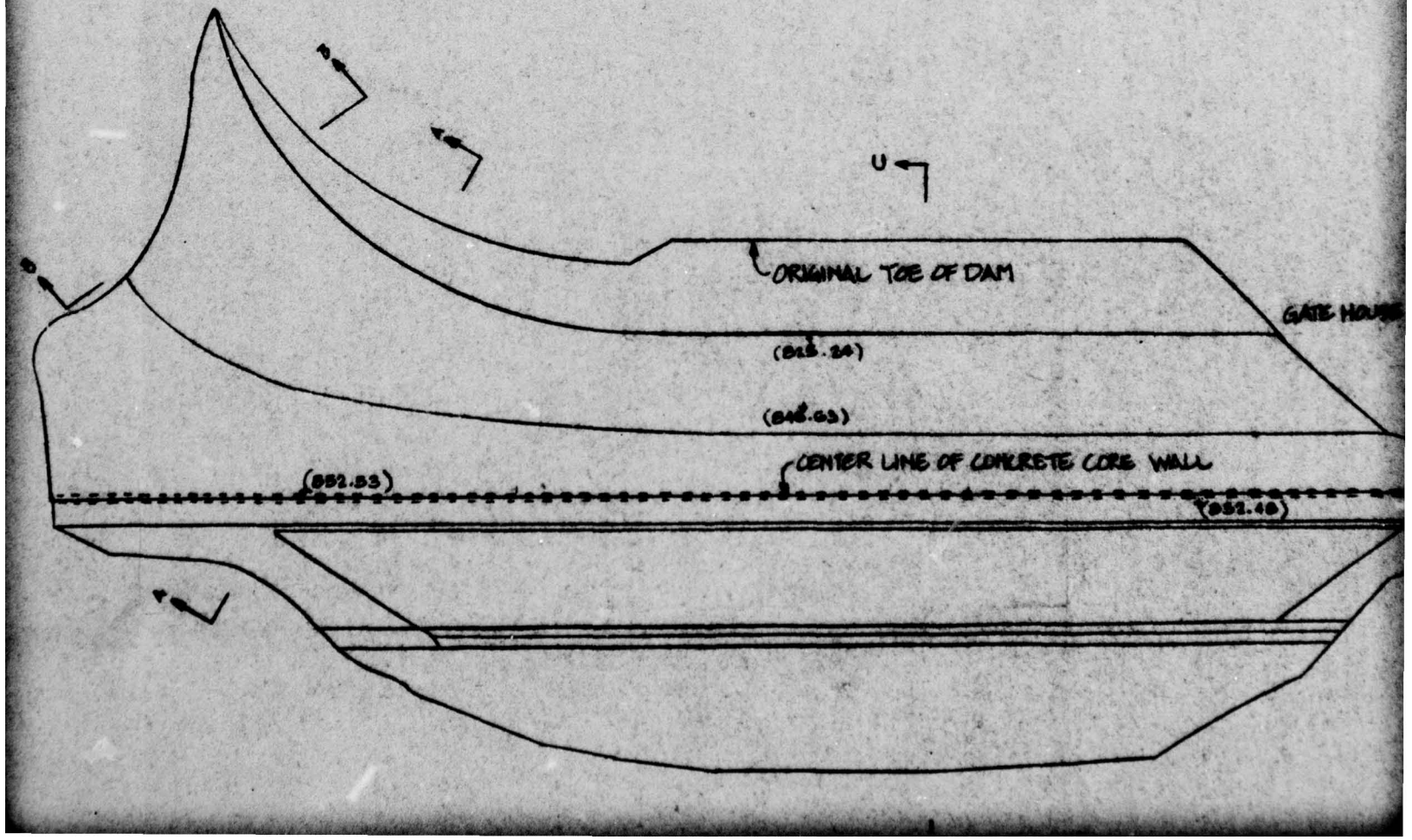
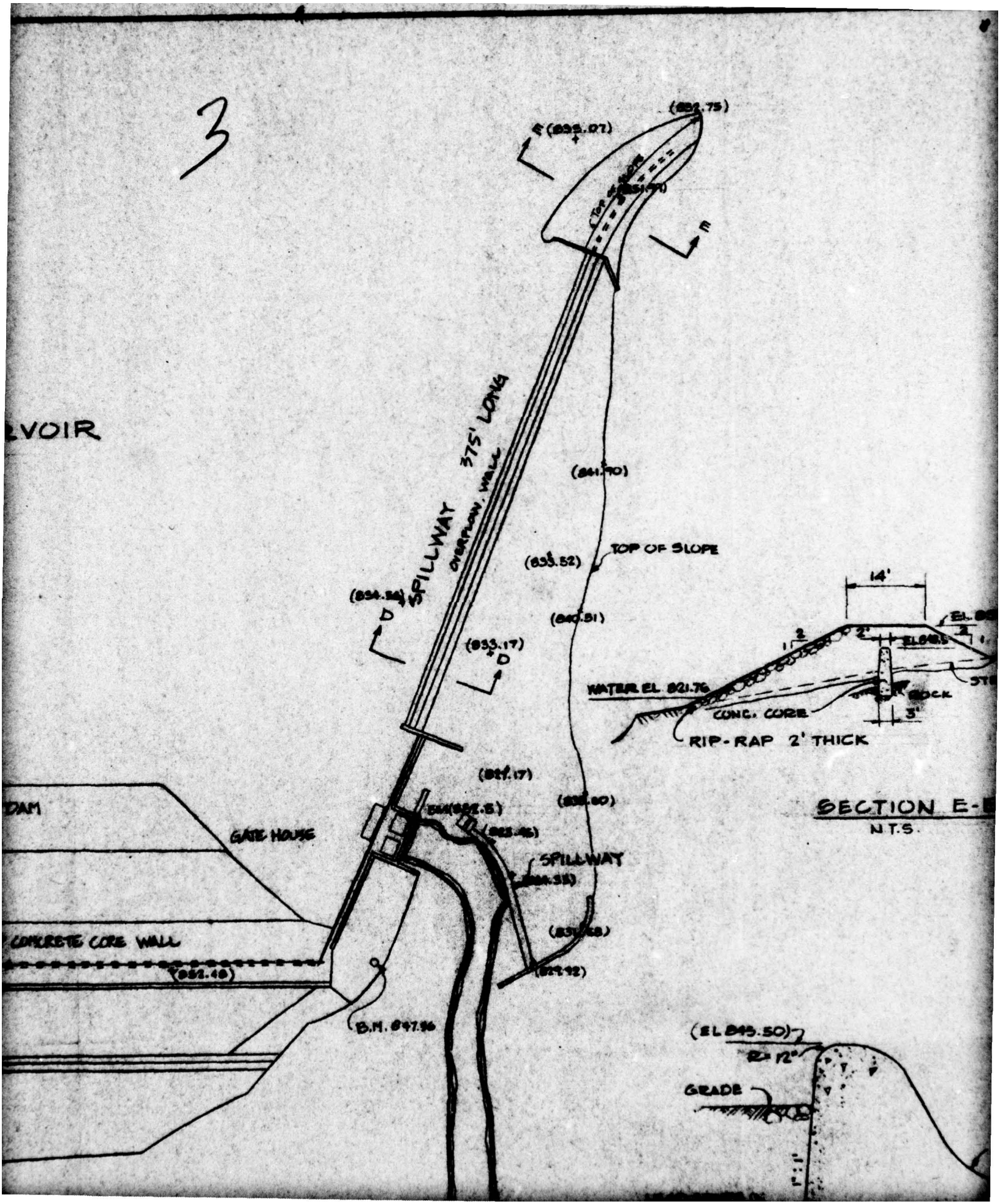
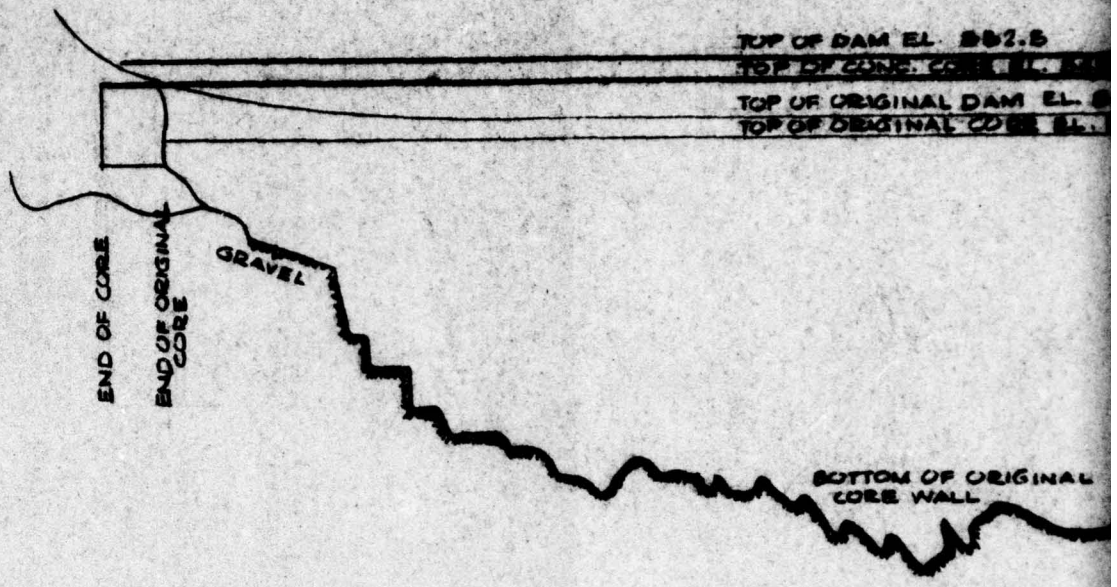
OAK RIDGE RESERVOIR
(EL. 821.76)

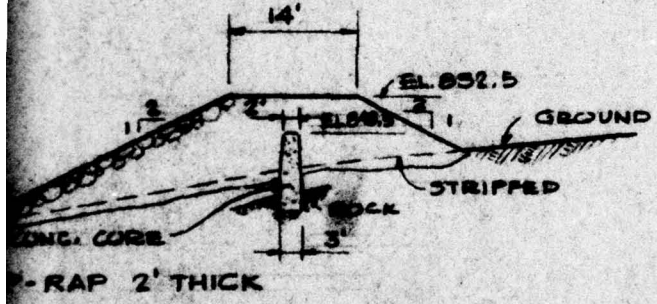



3
RVOIR
(852.75)
E (835.27)
E
(841.70)
SPILLWAY 375' LONG
OVERFLOW WALL
(834.34)
D
(833.17)
D
(833.52)
TOP OF SLOPE
(840.31)
14'
2'
EL 845.5
WATER EL 821.76
ROCK
CONC. CORE
3'
RIP-RAP 2' THICK
SECTION E-E
N.T.S.
(827.17)
(826.60)
GATE HOUSE
SPILLWAY
CONCRETE CORE WALL
(821.46)
B.M. 847.96
(EL 845.50)
R= 12"
GRADE

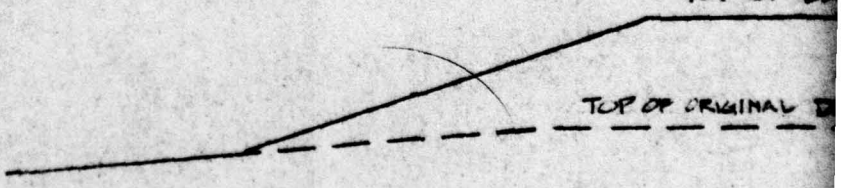
4

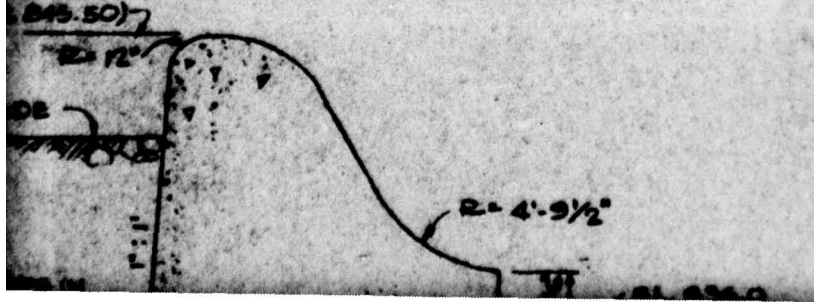


PROFILE
@ DAM
N.T.S.



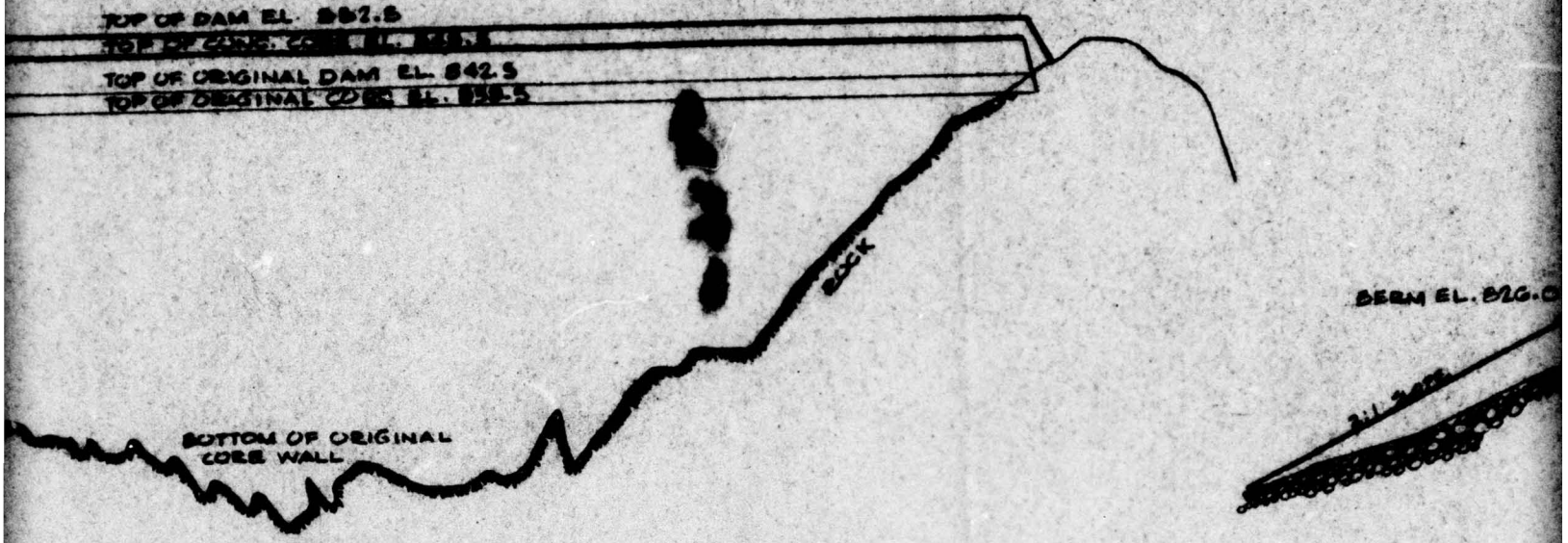
SECTION E-E
N.T.S.



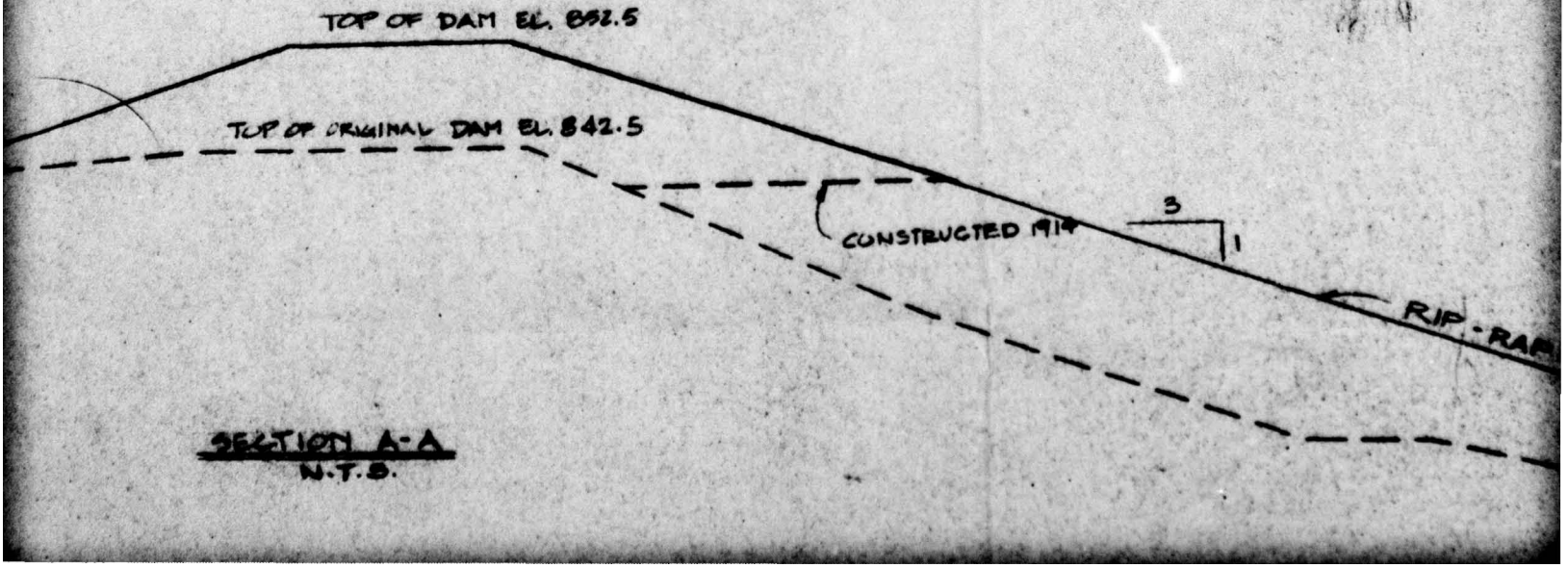


SECTION A-A
N.T.S.

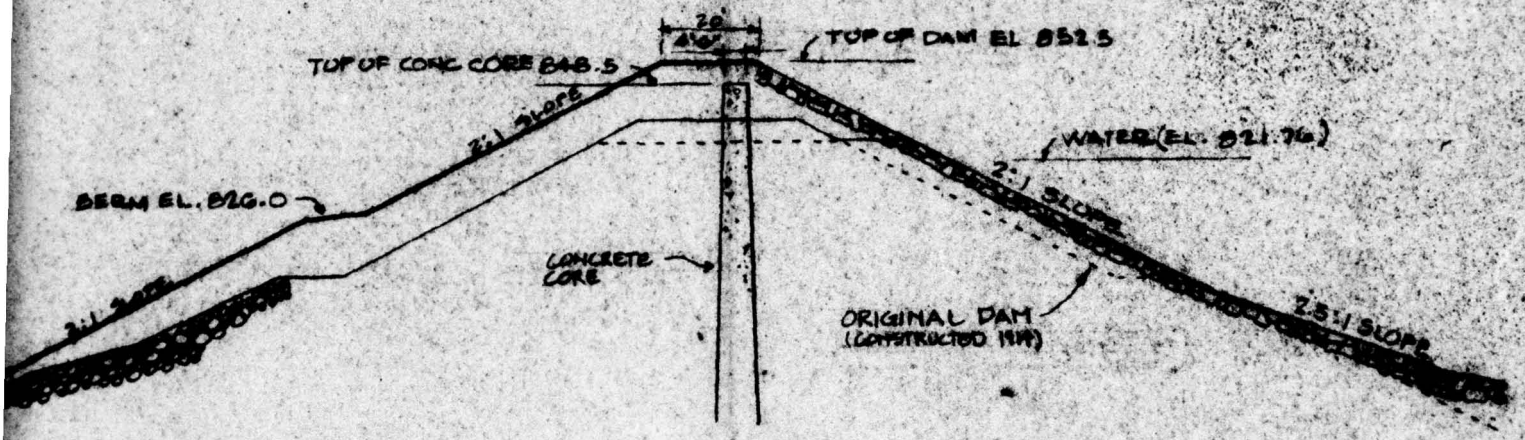
5



PROFILE
@ DAM
N.T.S.

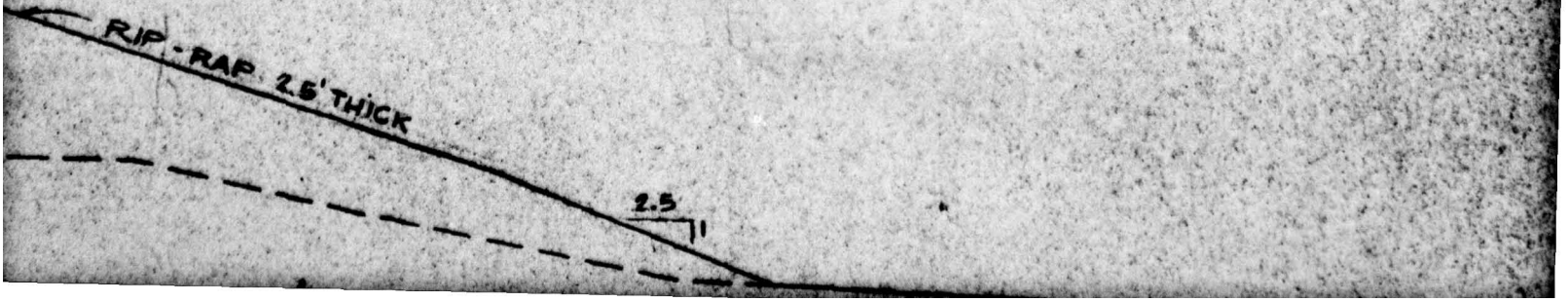


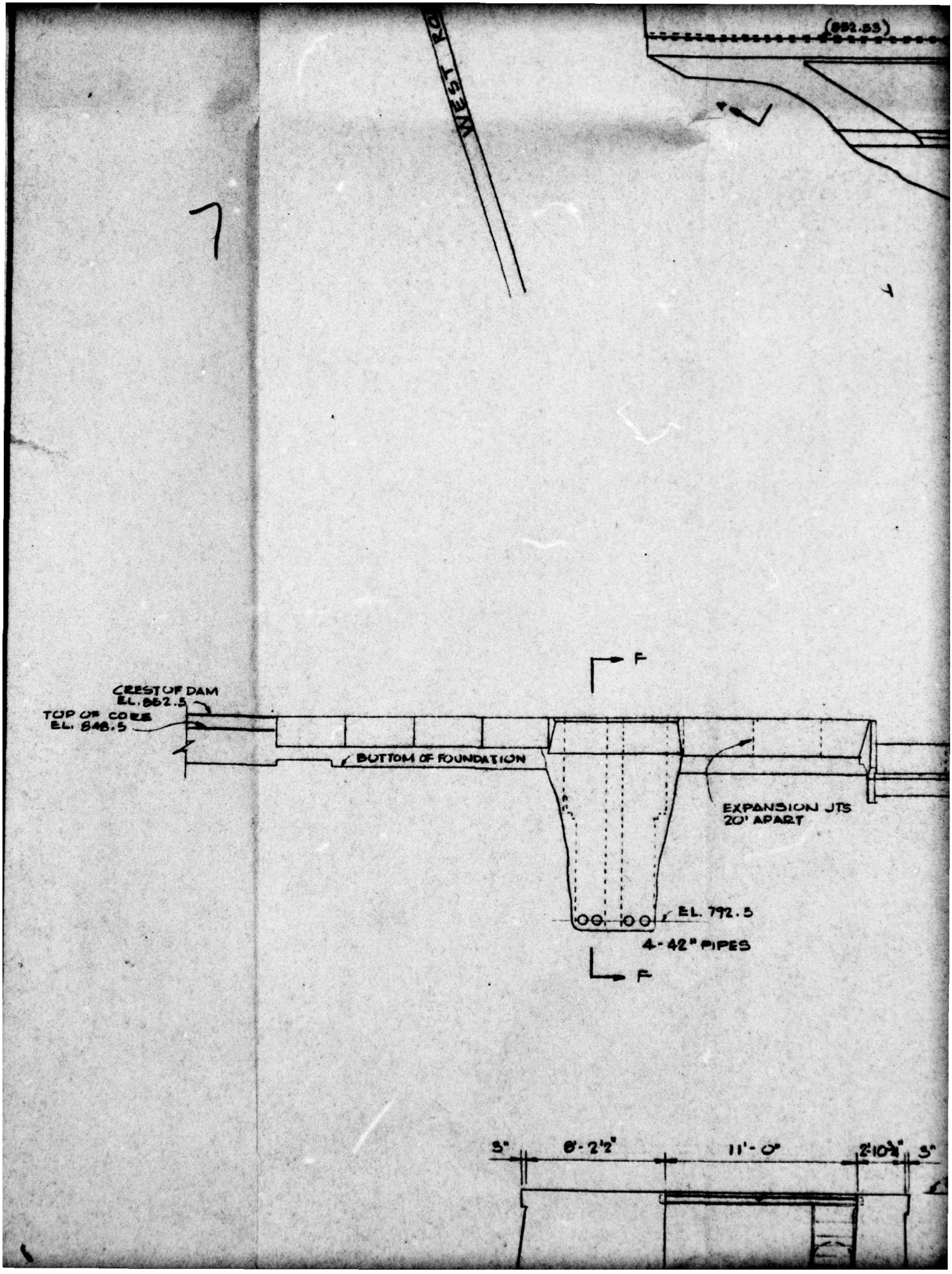
SECTION A-A
N.T.S.

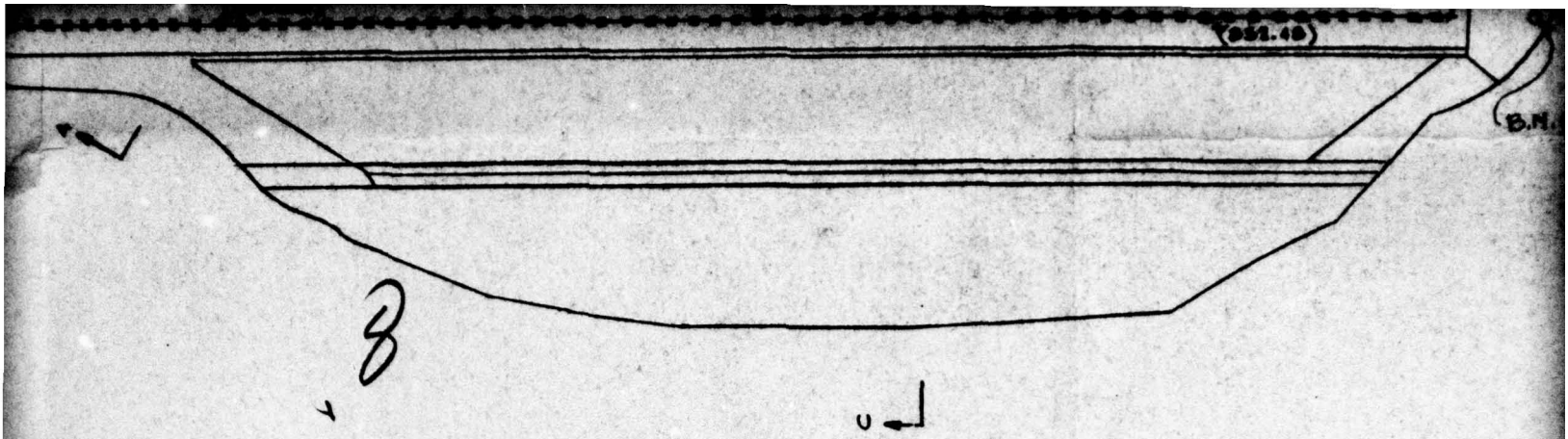


SECTION C-C

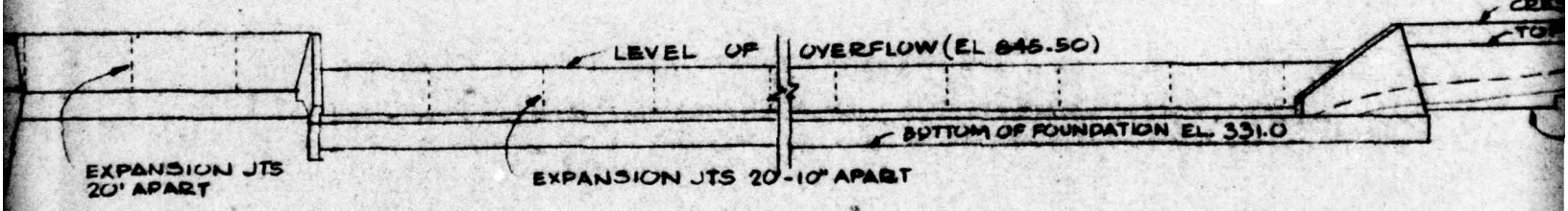
N.T.S.




WEST RO
(852.53)
F
CREST OF DAM
EL. 862.5
TOP OF CORE
EL. 848.5
BOTTOM OF FOUNDATION
EXPANSION JTS
20' APART
EL. 792.5
4-42" PIPES
F
5"
8'-2½"
11'-0"
2'-10½"
5"



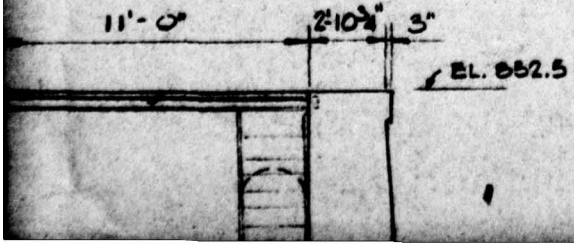
PLAN
N.T.S.

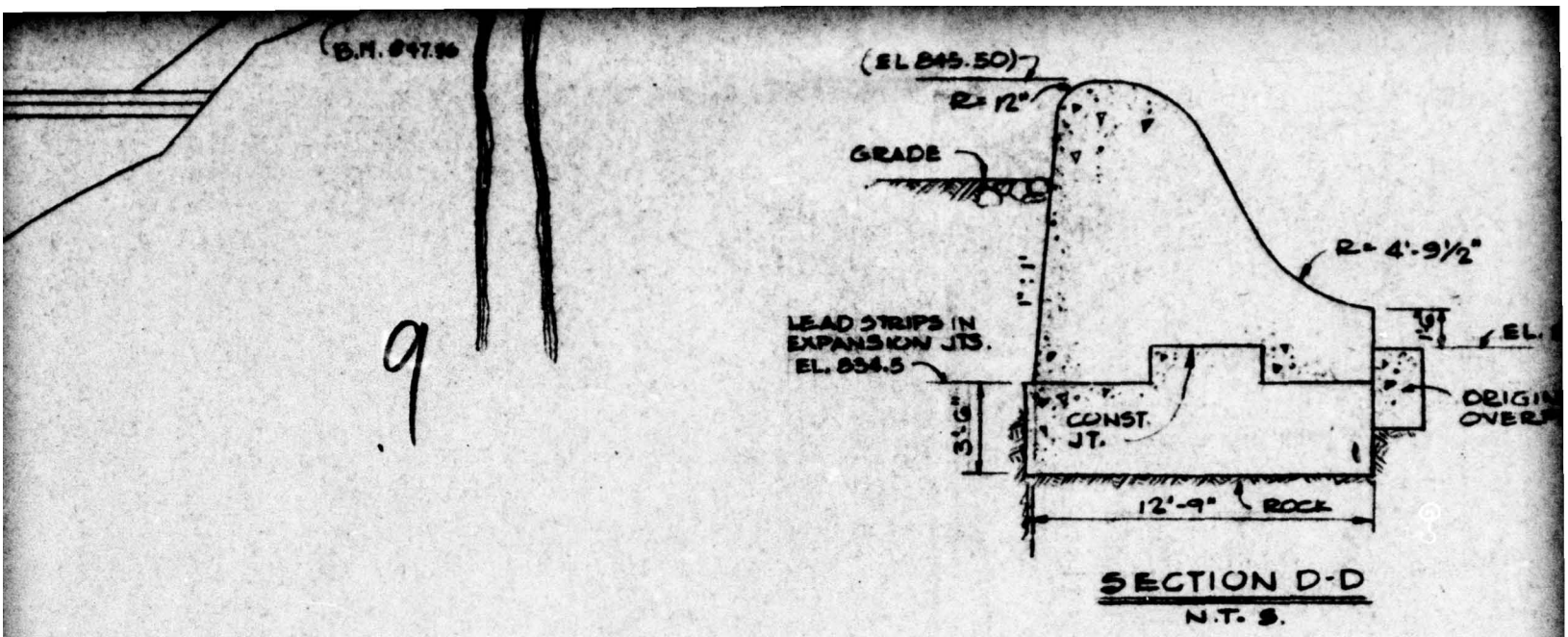


EL. 792.5

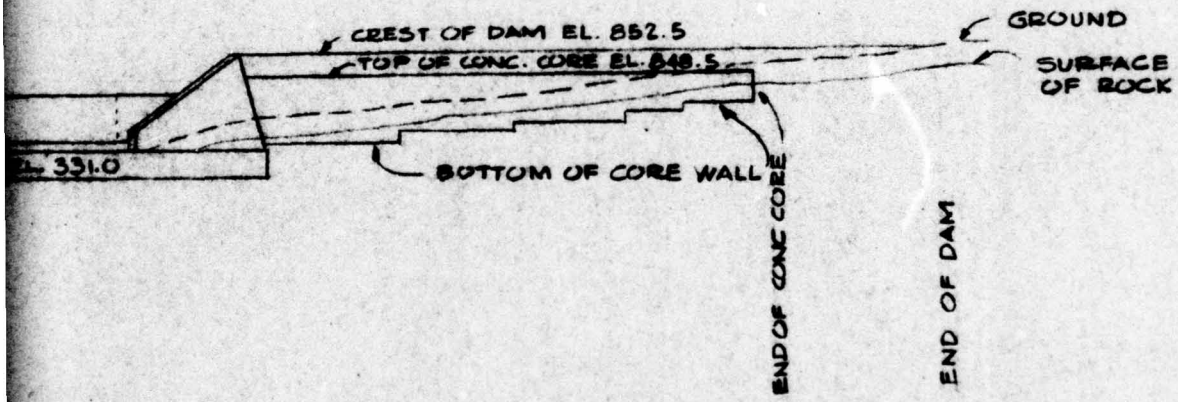
2" PIPES

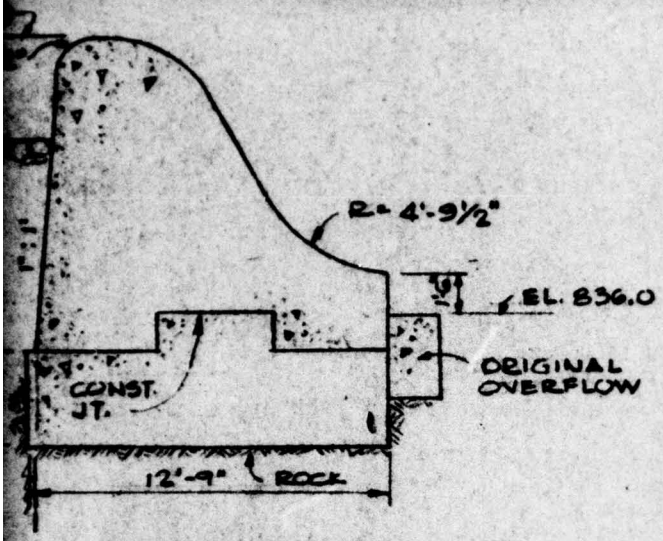
PROFILE
@ SPILLWAY
N.T.S.





SECTION D-D
N.T.S.





SECTION D-D
N.T.S.

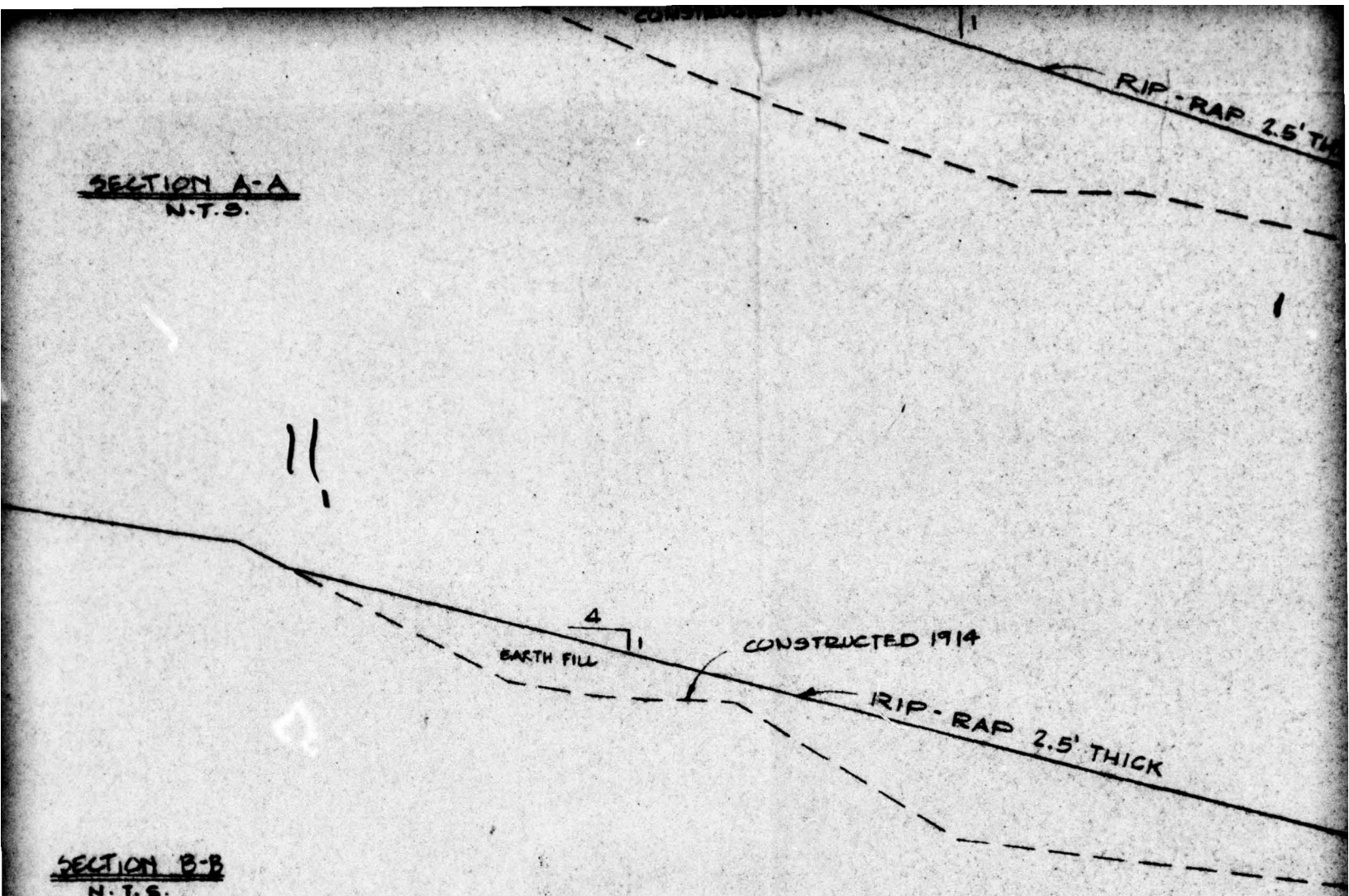
10

SECTION A-A
N.T.S.

SECTION B-B
N.T.S.

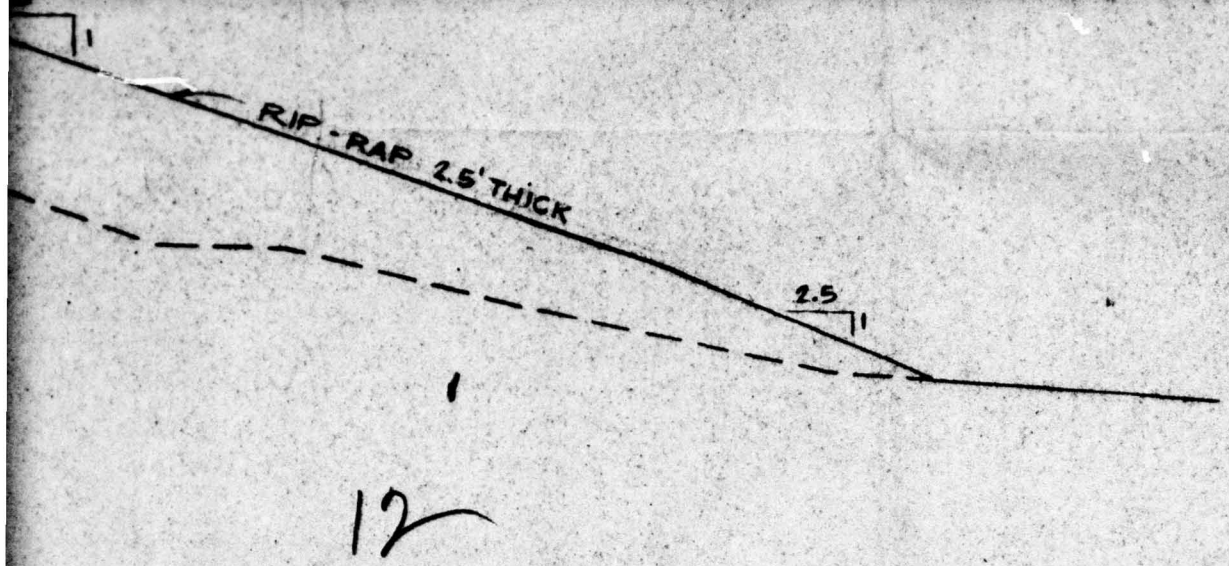
OUND

SURFACE
OF ROCK



SECTION A-A
N.T.S.

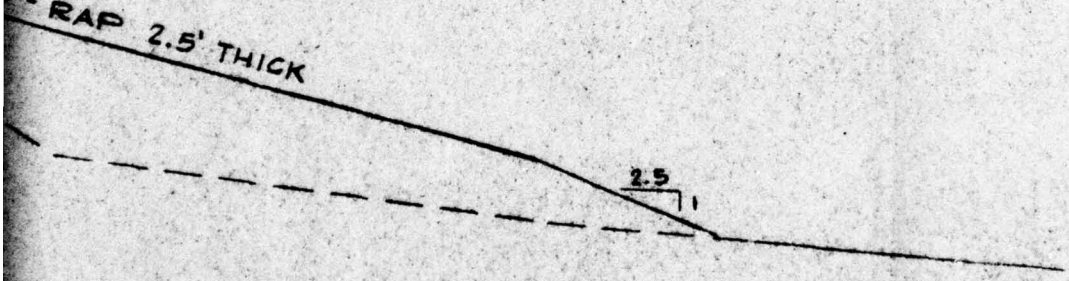
SECTION B-B
N.T.S.



1

12

1914

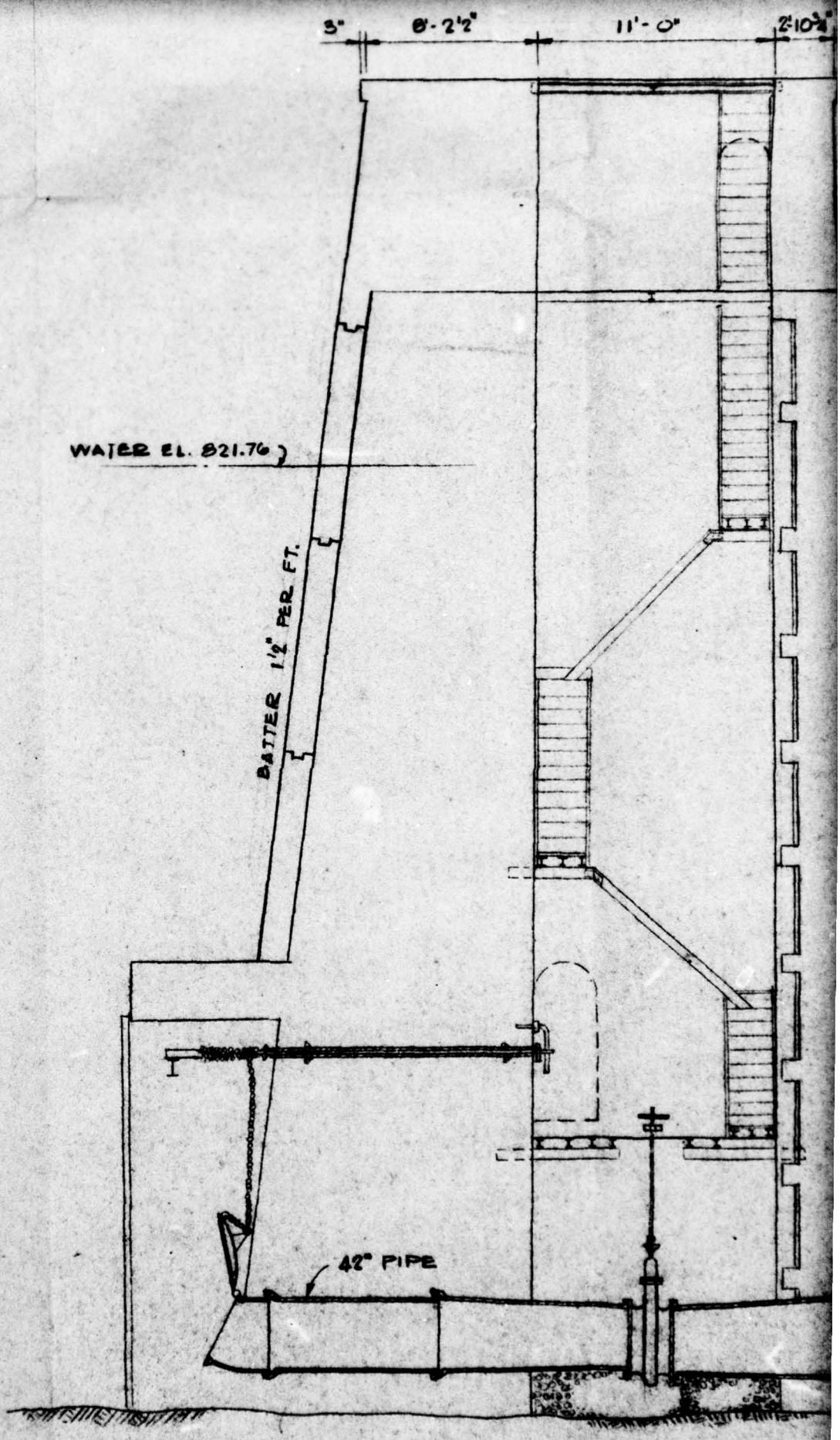


DATE	DESCRIPTION
	REVISIONS

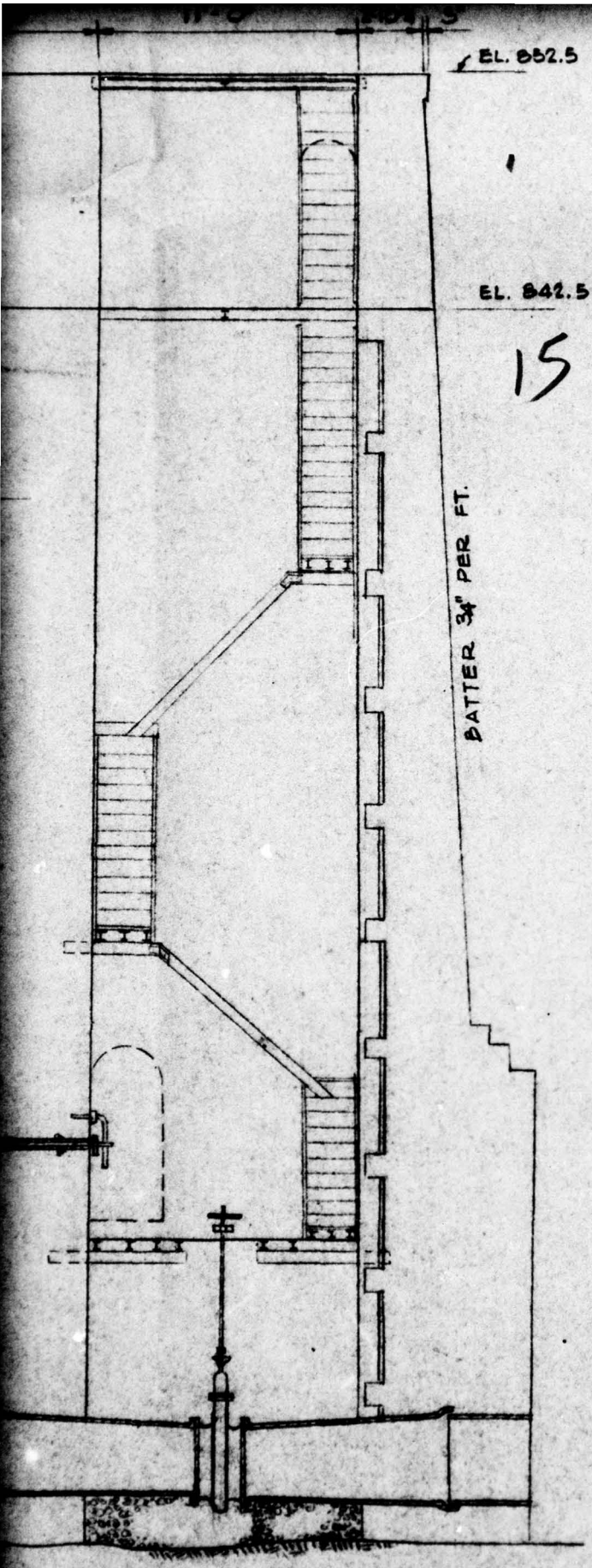
13.

DATE	DESCRIPTION	NO.
REVISIONS		

14



SECTION F-F
THRU GATEHOUSE
N.T.S.

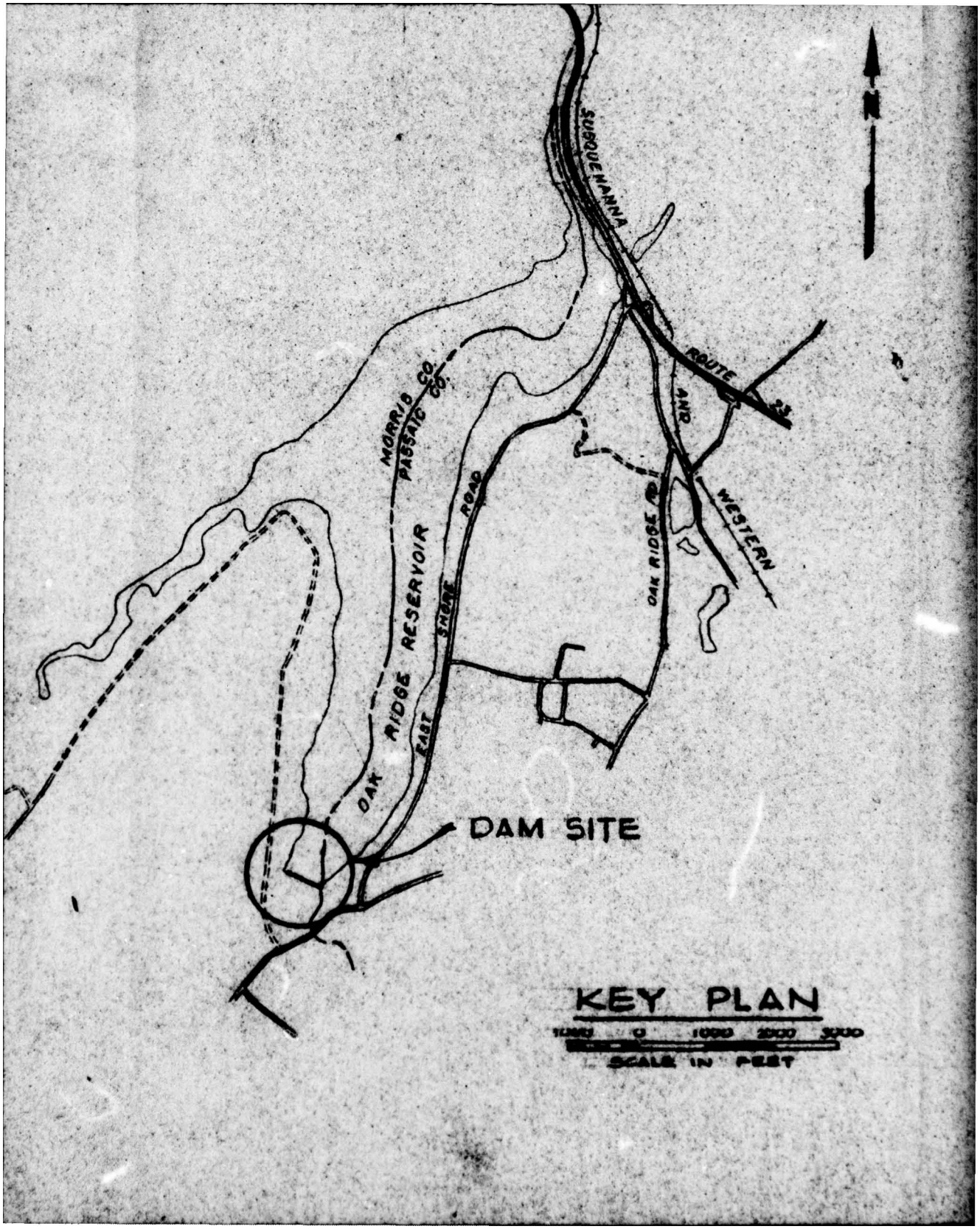


CTION F-F
GATEHOUSE
N.T.S.

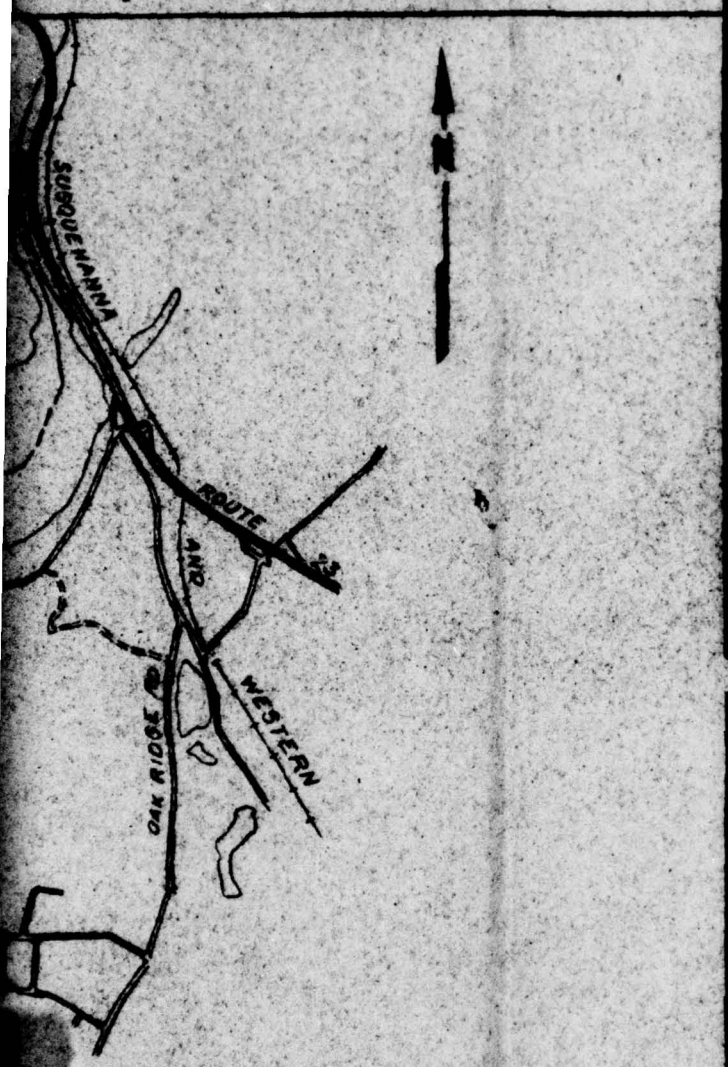
16

NOTE:

THE ELEVATIONS SHOWN WERE OBTAINED USING A SURVEYOR'S TRANSIT AND LEVEL, AND CONTRACT DWGS. OF THE BOARD OF STREET AND WATER COMMISSIONERS, DEPT. OF WATER, NEWARK, N.J., OAKRIDGE RESERVOIR, MARCH 19, 1917. THE BENCHMARK ELEVATION OF 852.50 ON THE SLAB OF THE GATEHOUSE WAS USED, AS SHOWN ON SAID DWGS. ELEVATIONS IN PARENTHESES FROM LANGAN ENG. ASSOC. FIELD SURVEY. ELEVATIONS ARE APPROXIMATE. INFORMATION SHOWN BELOW GROUND SURFACE AND WATER LEVEL HAVE NOT BEEN CONFIRMED.


SUSQUEHANNA
MORRIS & PASSAIC CO.
ROUTE 23
AND
WESTERN
OAK RIDGE RESERVOIR
EAST SHORE ROAD
OAK RIDGE
DAM SITE
KEY PLAN
SCALE IN FEET

DATE	DESCRIPTION	NO.
REVISIONS		



SITE

KEY PLAN

0 1000 2000 3000

SCALE IN FEET

PROJECT

PHASE I

INSPECTION & EVALUATION of NEW JERSEY DAMS

DRAWING TITLE

OAK RIDGE

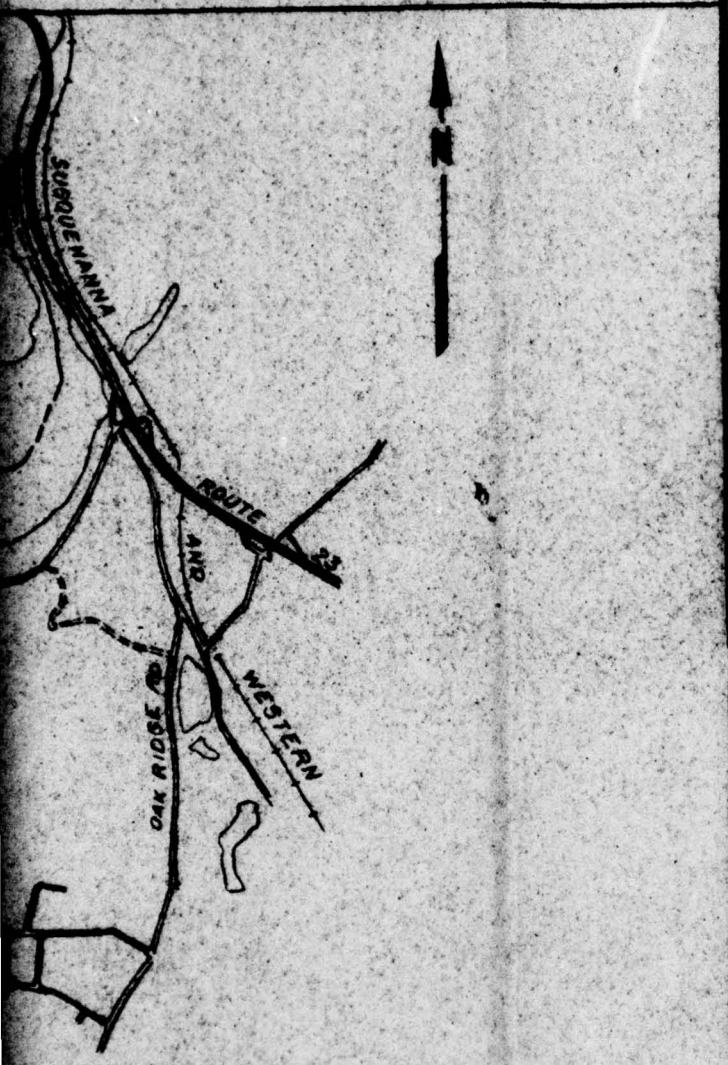
NOVEMBER 1978

FED. I. D. NO. N.J. 00014

JOB NO. J-783B	DRAWING NO. FIG. 2
DATE 11/14/78	
SCALE AS NOTED	
DRN. BY J.G. & J.R.	
CHKD. BY D.J.L	

9

DATE	DESCRIPTION	NO.
REVISIONS		



SITE

KEY PLAN

0 1000 2000 3000

SCALE IN FEET

PROJECT

PHASE I

INSPECTION & EVALUATION of NEW JERSEY DAMS

DRAWING TITLE

OAK RIDGE

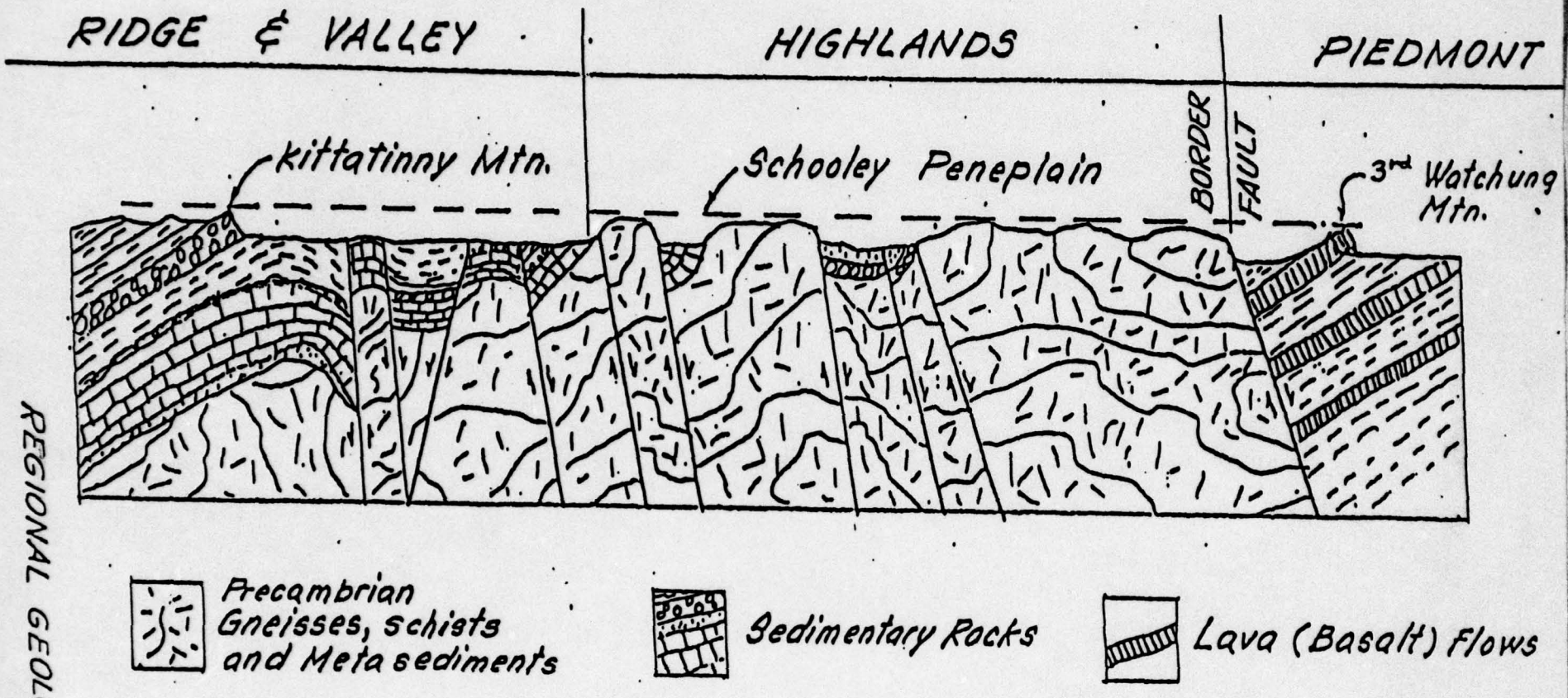
NOVEMBER 1978

FED. I. D. NO. N.J. 00014

JOB NO. J-7838	DRAWING NO. FIG. 2
DATE 11/14/78	
SCALE AS NOTED	
DRN. BY J.G. & J.R.	
CHKD. BY D.J.L	

18

23



Schematic Cross-section of New Jersey Highlands Physiographic Province (After Wolfe; 1977)

REGIONAL GEOLOGIC FEATURES

Fig. 3

APPENDIX I

CHECK LIST

VISUAL INSPECTION

OAK RIDGE RESERVOIR

CHECK LIST
VISUAL INSPECTION
Phase I

NAME DAM Oak Ridge Reservoir Dam COUNTY Morris STATE New Jersey COORDINATORS N.J. DEP

DATE(s) INSPECTION See below WEATHER Overcast TEMPERATURE 33° F

POOL ELEVATION AT TIME OF INSPECTION 822* M.S.L. TAILWATER AT TIME OF INSPECTION 791* M.S.L.

*BM of 852.5 (ref. note Fig. 2)

INSPECTION PERSONNEL:

D. Leary (11/30/78) C. Campbell (12/6/78)

J. Richards (11/30/78) J. Rizzo (12/6/78)

P. Yu (12/6/78)

James Richards RECORDER

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Appears generally satisfactory. Small amount of debris in channel above bridge over Berkshire Valley Road.	Debris should be removed.
SLOPES	Appear satisfactory.	
APPROXIMATE NO. OF HOMES AND POPULATION	Greater than 100 homes. Population est greater than 300 (US Topo Map) within approx. 2 miles of dam. Homes are at high elevations; greater than el 800.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None observed.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Appear satisfactory.	
RIPRAP FAILURES	None observed.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
OTHER	Trees located right of discharge channel on downstream of dam.	Investigate present and future root systems and ensure they do not adversly affect downstream sections of dam.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Minor erosion at left embankment abutment.	Eroded areas should be repaired.
ANY NOTICEABLE SEEPAGE	Est. 40 gpm in small earth ditch adjacent to a wet spongy area downstream of dam.	Further investigation required.
STAFF GAGE AND RECORDER	None observed.	
DRAINS	None observed.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None observed.	
INTAKE STRUCTURE	Not applicable.	
OUTLET STRUCTURE	Appears satisfactory with minor spalling of concrete surface. Brush between outlet structure embankment and spillway.	Brush should be removed.
OUTLET CHANNEL	Appears satisfactory.	
EMERGENCY GATE	Operational Outlet Gates in gate chamber are in good working order.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARK OR RECOMMENDATIONS
SLOPES	Localized minor erosion along reservoir slopes.	
SEDIMENTATION	Does not appear to be a problem.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Concrete cracked and spalled in several locations on spillway. Some of the remedial work done previously has cracked. Construction joints have opened up in several areas.	Spalled and cracked areas should be suitably repaired. Joints should be repaired.
APPROACH CHANNEL	Appears satisfactory.	
DISCHARGE CHANNEL	Several of the 6 inch - 1½ ft diameter stones which protrude through the paved channel downstream of spillway are loose. Trees and brush along slopes of channel. Small cracks & disjointing in paved area of downstream spillway apron.	Loose stones should be suitably repaired. Trees & brush should be removed. Cracked areas and disjointing should be repaired.
BRIDGE AND PIERS	None observed.	
ABUTMENT	Left abutment has approximately 1/8" bulge and several small cracks. Concrete has spalled in 4 areas.	Abutment should be further investigated. Spalled concrete should be suitably repaired.

CONCRETE PORTION OF DAM (Outlet Chamber)

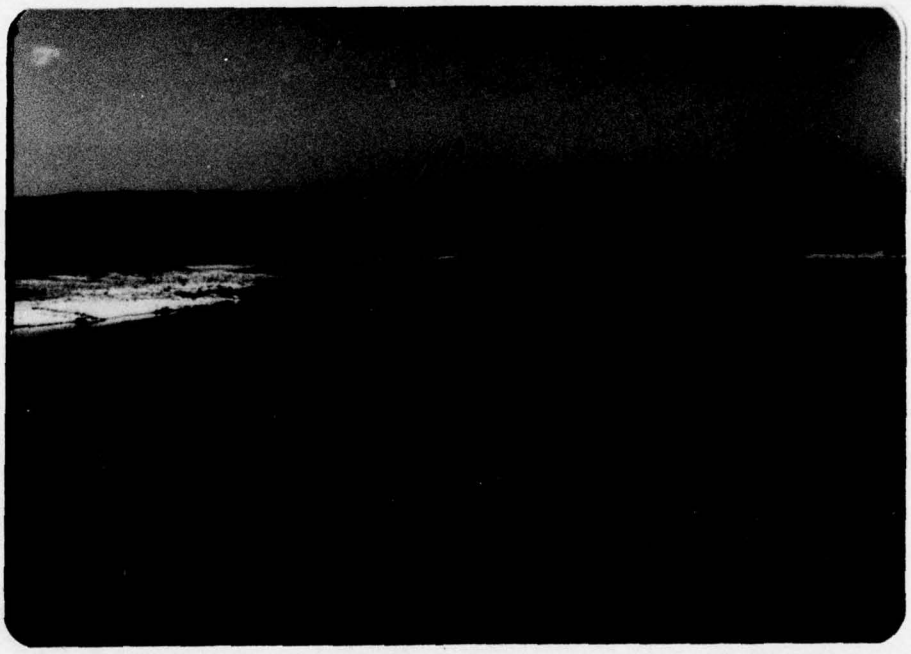
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS		
DRAINS	None observed.	
WATER PASSAGES	Good.	
FOUNDATION	Not observable.	

APPENDIX 2

PHOTOGRAPHS

OAK RIDGE RESERVOIR

Marshy area downstream of dam. Looking upstream. 30 November 1978

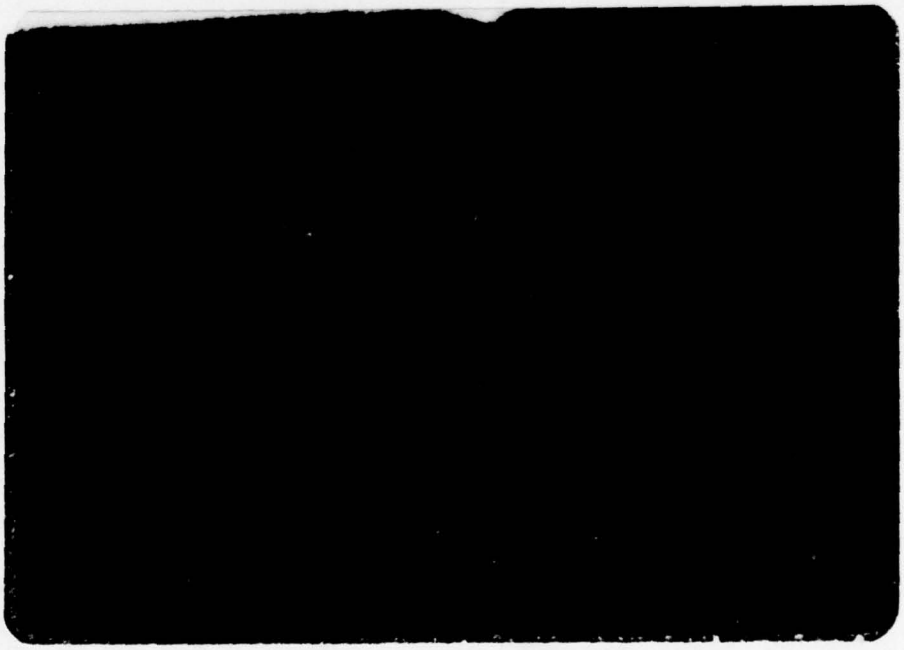


Oak Ridge Reservoir. Looking upstream. 30 November 1978

Spillway. Outlet chamber at right side of spillway. 30 November 1978

Paved spillway apron leading to rock gorge. 30 November 1978

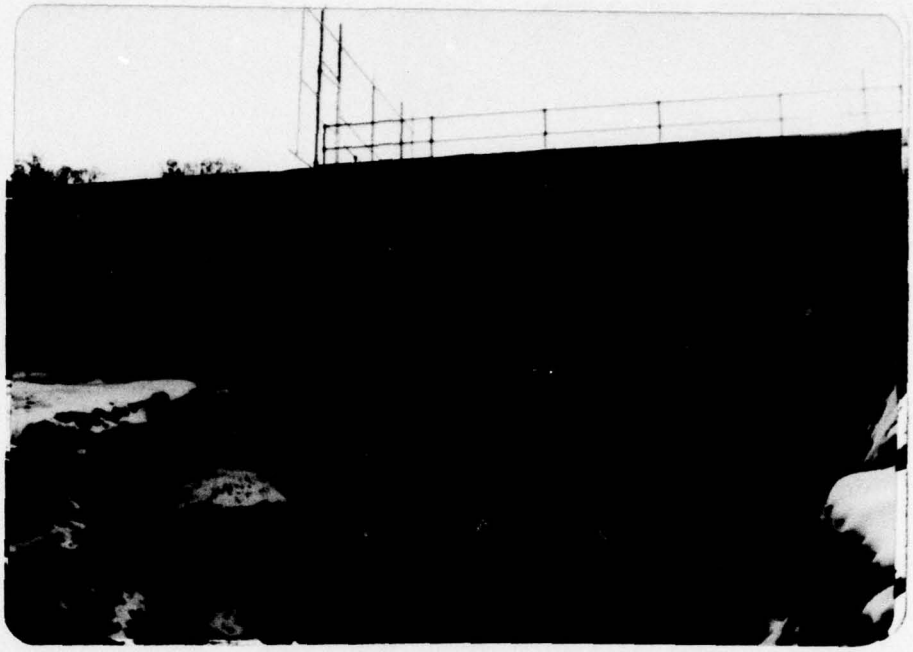
Deterioration of spillway concrete. 30 November 1978



Deterioration of spillway concrete. 30 November 1978

Deterioration of concrete at spillway left sidewall. 30 November 1978

Entrance channel to outlet chamber. 30 November 1978



Concrete deterioration at upstream surface of outlet chamber. 30 November 1978

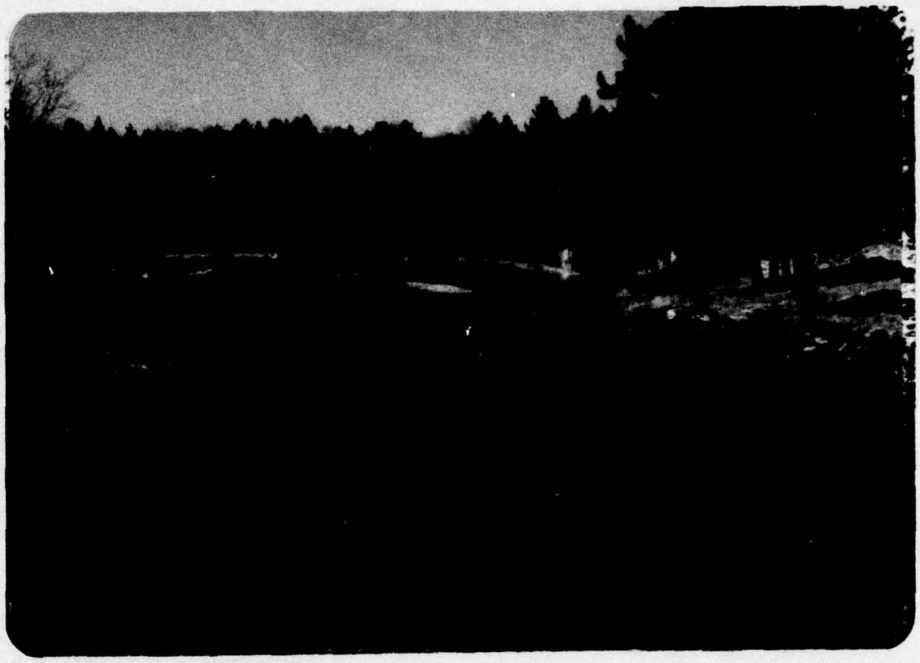
Outlet chamber and right side of spillway. Looking upstream. 30 November 1978

Discharge from pipes at bottom of outlet chamber and into rock gorge discharge channel. Looking upstream. 30 November 1978

Rock gorge discharge channel below outlet chamber and spillway apron. Looking downstream. 30 November 1978

Discharge channel. Looking upstream from Berkshire Valley Road. 30 November 1978

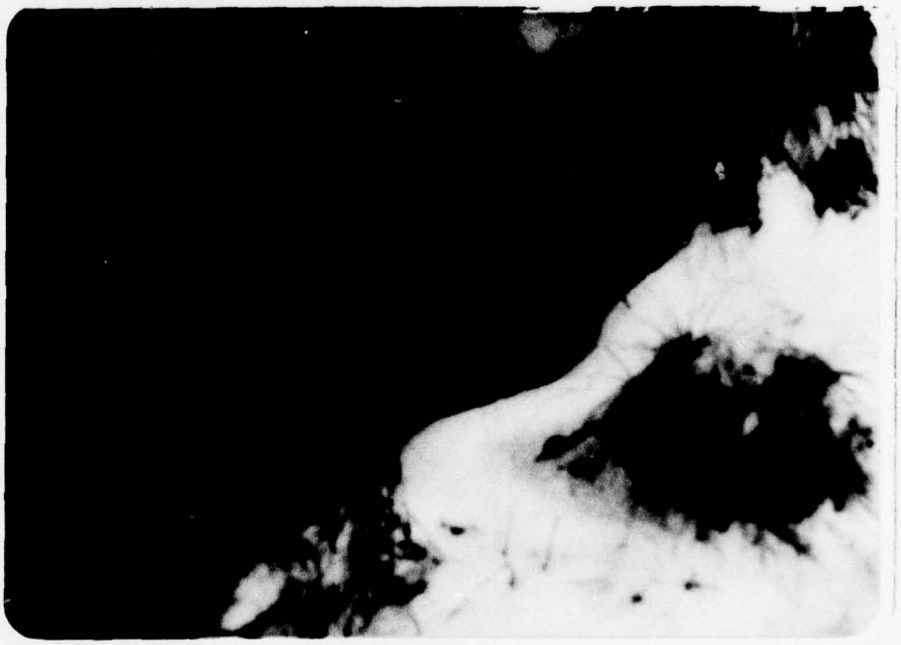
Berkshire Valley Road bridge over discharge channel. Looking North. 30 November 1978



Discharge channel east of Berkshire Valley Road. Looking upstream. 30 November 1978

Riprap at upstream slope of dam. 30 November 1978

Animal burrow at downstream toe of dam. 30 November 1978



Discharge from possible spring. 30 November 1978
Flow approx. 40 gpm.

APPENDIX 3

HYDROLOGIC COMPUTATIONS

OAK RIDGE RESERVOIR

LANGAN ENGINEERING ASSOCIATES, INC.

HYDROLOGIC COMPUTATIONS

OAK RIDGE RESERVOIR DAM

Location Morris County, N.J. in the Passaic River Basin

Drainage Area 17308 acres or 27 sq. mi.

Lake Area 421 acres

Classification Size – Intermediate
Hazard – Significant

Spillway Design Flood (SDF) In accordance with evaluation criteria, ½PMF to PMF should be used. PMF is chosen for analysis.

PMP

1. Dam located in boundary area of Zone 1 and Zone 6
   PMP = 22.1 inches

2. PMF must be adjusted for basin size

Duration	% Factor (for 27 sq. mi) Zone 1	Zone 6	Average	Reduction Factor*
0-6	100	104	102	
0-12	113	113	113	.821
0-24	123	122	123	
0-48	132	134	133	

* p. 48 "D.S.D."

BY. Py DATE 1-16-79, 3-4-79 Oak Ridge Reservoir Dam JOB NO. J-783

CKD GED DATE 4-3-79 SHEET NO. 1 OF 10

Unit Hydrograph

Corp of Engineers has indicated that Snyder Method be used and has provided the following coefficients :

$C_t = 2.0$, $C_p = 0.4$

Snyder Lag time

$t_p = C_t (L \cdot L_{ca})^{0.3}$

from drainage area

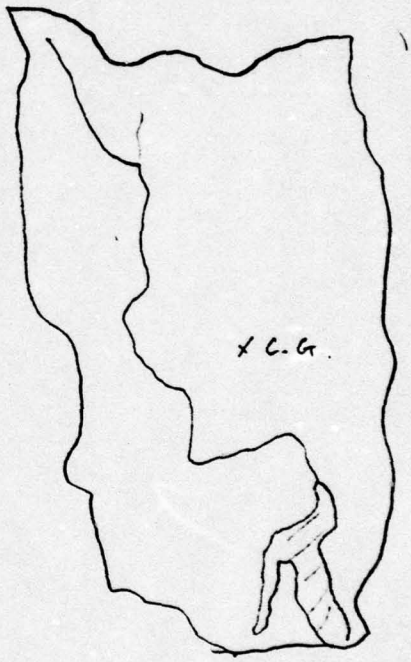
$L = 50000\,ft = 9.47\,mi.$

$L_{ca} = 24000\,ft = 4.55\,mi$

$\therefore t_p = 2.0(9.47 \times 4.55)^{0.3}$

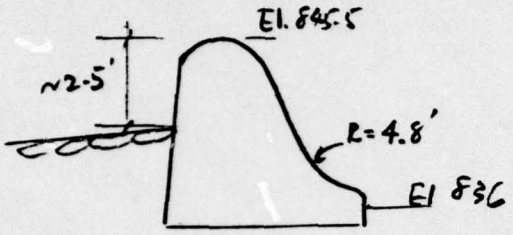
$\doteq 6.18\,hrs.$

$\therefore t_p = 6.18\,hrs,\ C_p = 0.4$

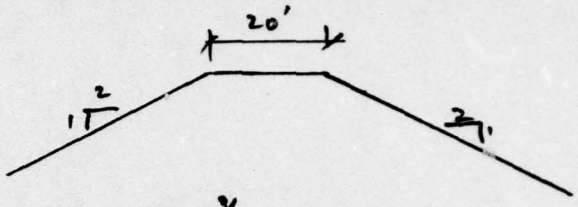


SPILLWAY CAPACITY

Spillway section (Ogee)



Embankment Section (Typ.)



$Q = CLH^{3/2}$

a) Determine C_o for discharge equation from "Design of Small Dams"

Based on the shape of the spillway section, and with reference to Table 9-3 on pg. 214 of "Practical Hydraulics" by A.L. Simon, assume the design head, $H_o = 4'$

Obtain C_o from Fig. 249 on pg. 378 of "D.S.D.",

$C_o = 3.81$

Determine the coefficient-head relation from Fig 250 of "D.S.D." , $L = 375'$ for spillway

$\therefore Q = 375\, CH^{3/2}$

b). Embankment section is similar to weir of trapezoidal cross-section, use $C = 3.0$ and take $L = 900$ ft

$\therefore Q = 2700\, H^{3/2}$

For spillway

$$Q = 375\,CH^{3/2}$$

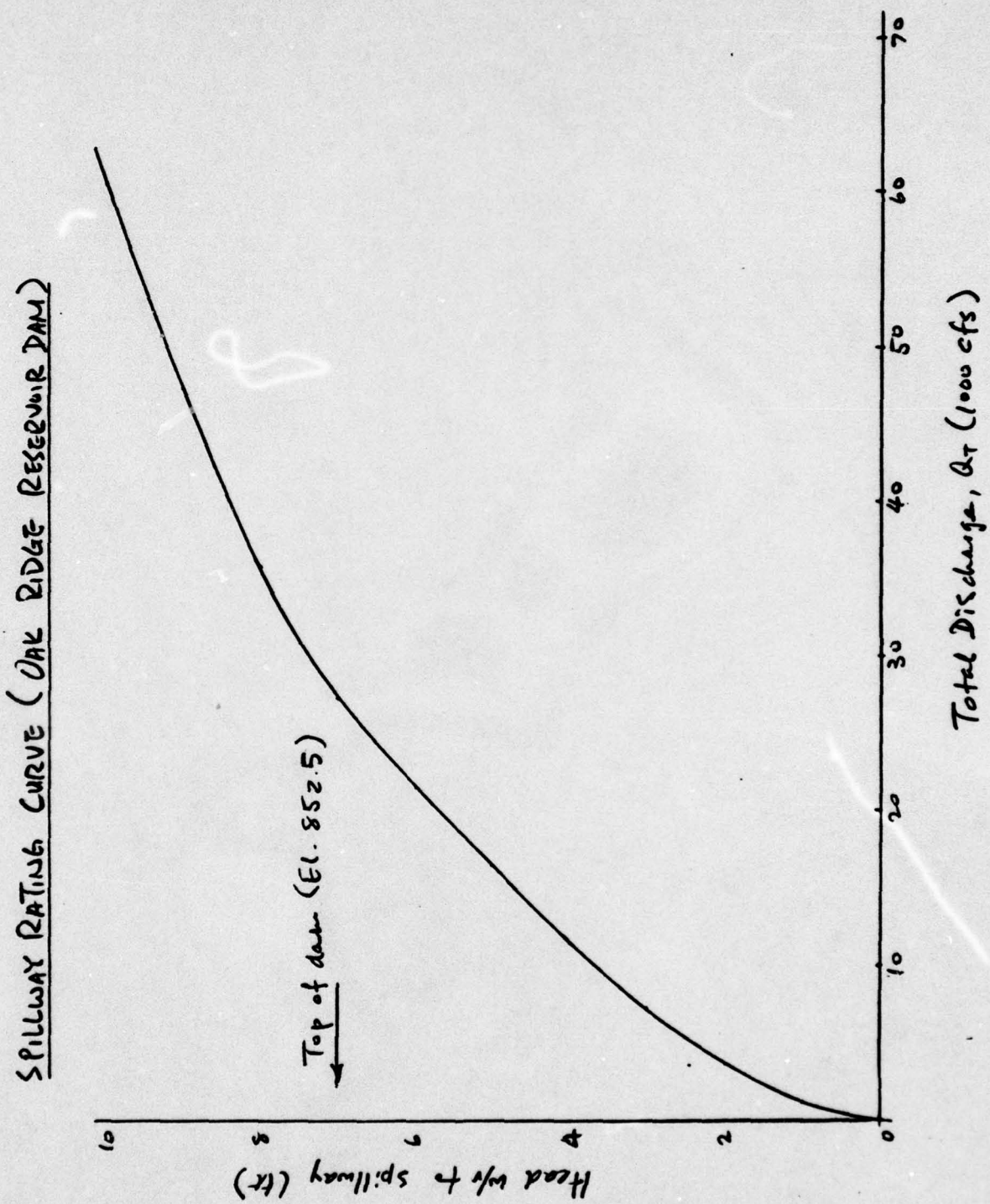
For embankment

$$Q = 2700\,H^{3/2}$$

Elev. (ft)	Spillway					Embankment		Total (cfs)	
	H (ft)	H/H_0	Y/Y_0	C*	Q_S (cfs)	H (ft)	Q_E (cfs)	$Q_T = Q_S + Q_E$	
845.5	0				0			0	
846.5	1	0.25	0.87	3.31	1241			1241	
847.5	2	0.5	0.92	3.51	3723			3723	
848.5	3	0.75	0.96	3.66	7132			7132	
849.5	4	1.0	1.00	3.81	11430			11430	
850.5	5	1.25	1.03	3.92	16435			16435	
851.5	6	—	—	3.92	21605			21605	
852.5	7	—	—	3.92	27225	0	0	27225	Top of Dam El. 852.5
853.5	8	—	—	3.92	33262	1	2700	35962	
854.5	9	—	—	3.92	39690	2	7637	47327	
855.5	10	—	—	3.92	46485	3	14030	60515	

* Take maximum C value = 3.92

LANGAN ENGINEERING ASSOCIATES, INC.



BY DJ DATE 2-20-79, 3-9-79 Oak Ridge Reservoir Dam JOB NO. J-783B

CKD GED DATE 4-3-79 SHEET NO. 5 OF 10

Reservoir Storage Capacity

Assume a linear distribution for the area of the lake with elevation. Start at a zero storage at the crest of the spillway.

Area of Lake = 421 Acres

Length of equivalent square ≐ 4282 ft

Take average side slope of 1V : 4H

∴ for every foot of water above the crest of spillway, the length of equivalent square increases by

= 1 × 4 × 2 = 8 ft

Elev. (ft)	H (ft)	Length of equivalent square (ft)	Area of Lake (Acres)
845.5	0	4282	421
852.5	7	4338	432
855.5	10	4362	437

SUMMARY OF HYDROGRAPH AND FLOOD ROUTING

1. Hydrograph was calculated using HEC-1
2. PMF peak inflow for Oak Ridge Reservoir is 19441 cfs which is less than the spillway capacity of 27225 cfs. Therefore, the spillway is adequate and routing is not necessary.

DRAWDOWN ANALYSIS

1. Outlet Structure

   4 - 42" Φ C.I. pipe

2. Outlet Capacity

Discharge capacity is based on

$Q = C_p \times H^{1/2}$ where $C_p = A_p \Big/ \sqrt{\frac{2g}{1 + K_m + K_p L}}$

for each pipe, $A_p = 9.62\ ft^2$

Use $n = 0.025$, then $K_p = 0.0218$ (NEH Section 5, ES-42)

use $K_m = 0.9$ $\therefore C_p = 9.62 \sqrt{\frac{64.4}{1 + 0.9 + 0.0218 \times 34}} = 47.5$

$\therefore Q_p = 47.5 H^{1/2}$

For four pipes $Q_p = 190 H^{1/2}$.

El. of centerline of pipe = 792.5 ft

Elev. (ft)	Head (ft)	Q (cfs)
845.5	53	1383
842.5	50	1344
837.5	45	1275
832.5	40	1202
827.5	35	1124
822.5	30	1041
817.5	25	950
812.5	20	850
807.5	15	736
802.5	10	601
797.5	5	425
792.5	0	

3. Storage Capacity

a. Estimated storage below spillway is 12,000 ac. ft.

b. Assume area varies linearly with height, assume bottom of lake at 797.5', area ≐ 79 acres

Elev. (ft)	Area (Ac.)	Δ Storage (ac-ft)	Total Storage
845.5	421		
		1231	12000
842.5	400		
		1909	
837.5	364		
		1729	
832.5	328		
		1553	
827.5	293		
		1375	
822.5	257		
		1198	
817.5	222		
		1020	
812.5	186		
		839	
807.5	150		
		662	
802.5	115		
		484	
797.5	79		

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4. Assume inflow to be 2cfs/sq.mi.

$Q_{in} = 27 \times 2 = 54$ cfs.

Elev. (ft)	Q_{out} (cfs)	$Q_{out\,avg.}$ (cfs)	Q_{net}* (cfs)	Δ Storage (Ac-ft)	Δt (hr.)	$\Sigma \Delta t$ (hr)
845.5	1383	1364	1310	1231	11	
842.5	1344	1310	1256	1909	18	
837.5	1275	1239	1185	1729	18	
832.5	1202	1163	1109	1553	17	
827.5	1124	1083	1029	1375	16	
822.5	1041	996	942	1198	15	
817.5	950	900	846	1020	15	
812.5	850	793	739	839	14	
807.5	736	669	615	662	13	
802.5	601	513	459	484	13	150
797.5	425					

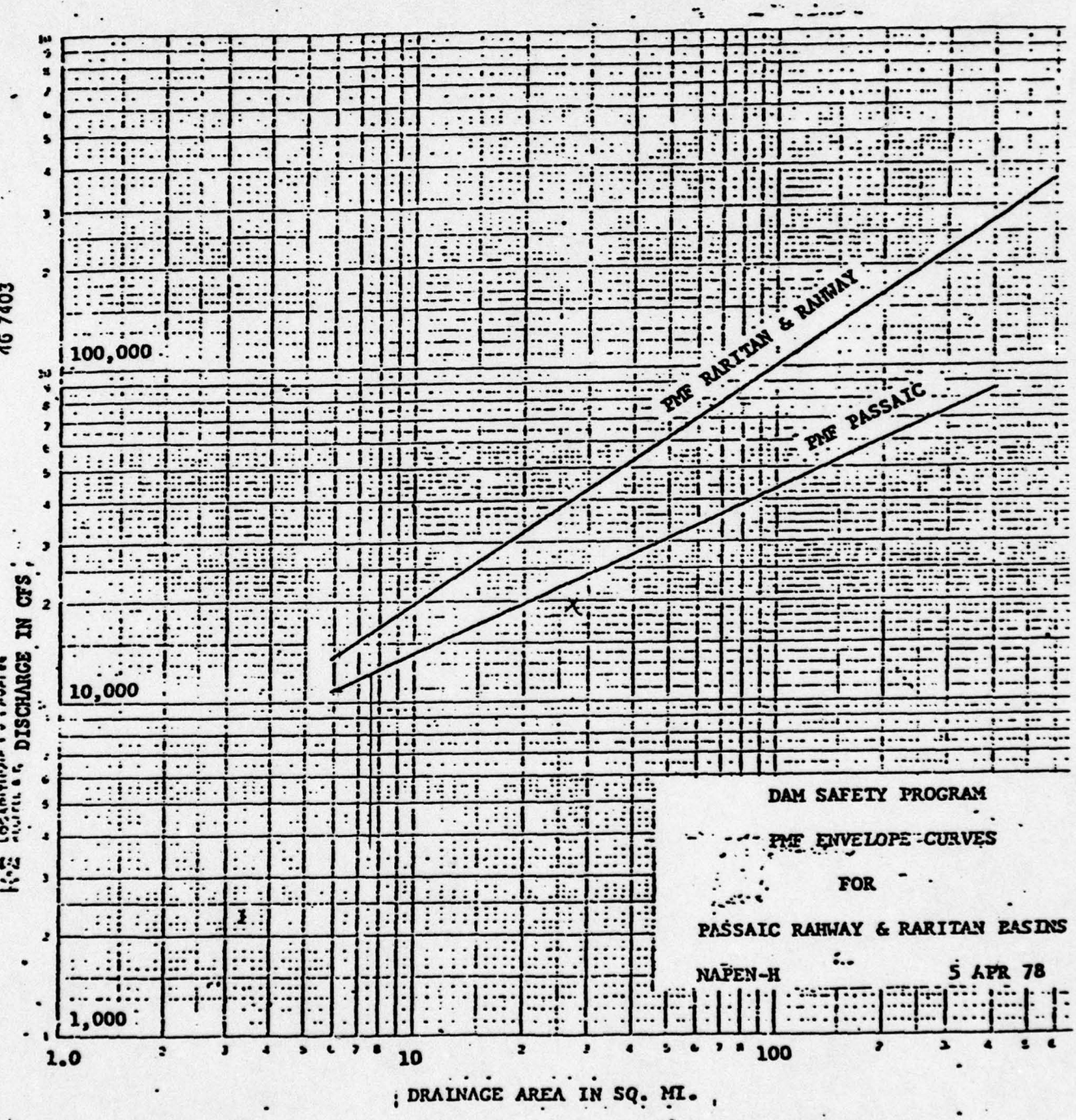
or 6.3 Days

* $Q_{net} = Q_{out\,avg} - Q_{in}$
$= Q_{out\,avg} - 54$ cfs

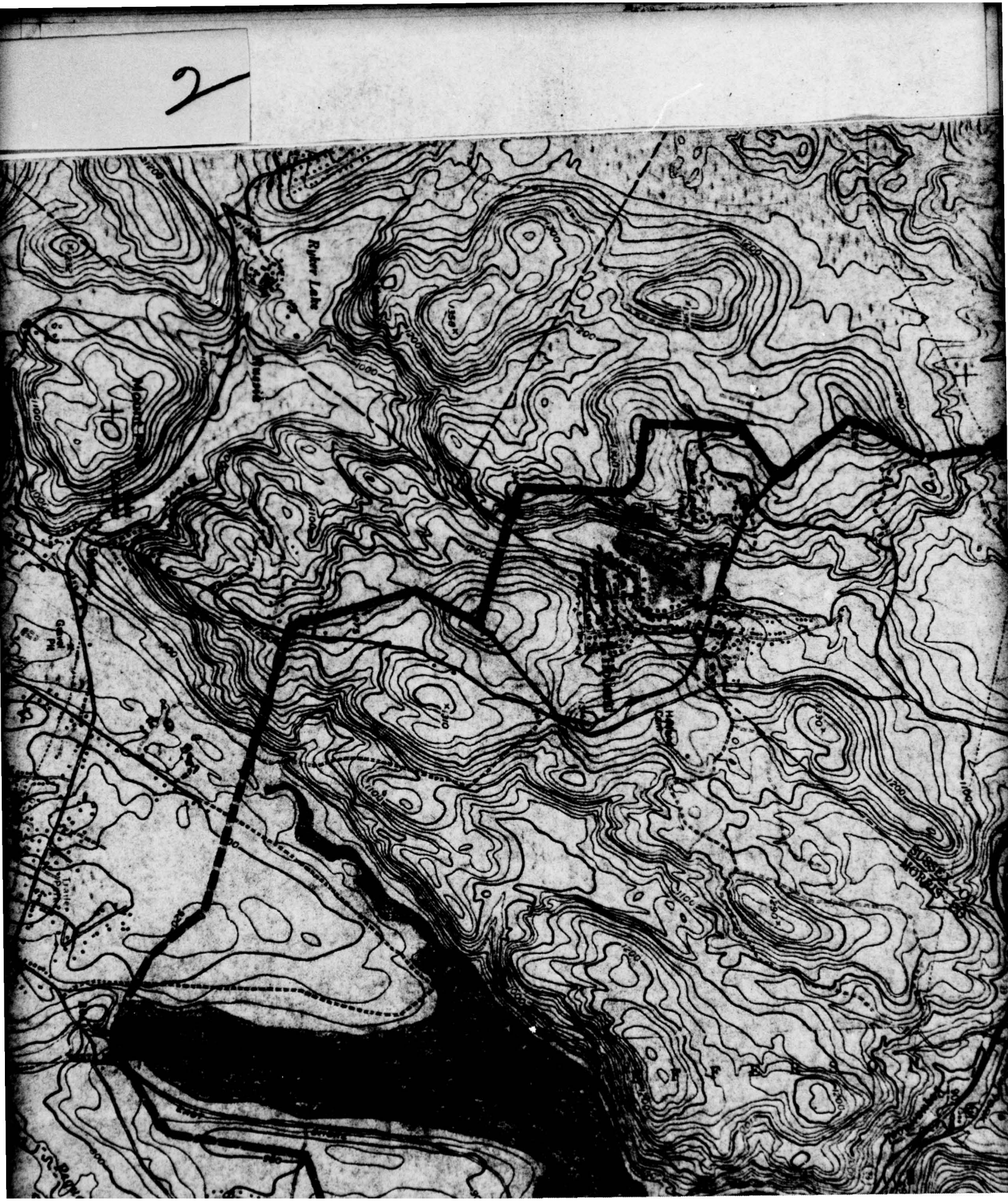
∴ Reservoir lowered by 48' in about 6 days

BY Dry DATE 1-20-79 Oak Ridge Reservoir Dam JOB NO. J-783 8

CKD GED DATE 4-3-79 SHEET NO. 10 OF 10


PMF RARITAN & RAHWAY
PMF PASSAIC
100,000
10,000
1,000
1.0
10
100
DISCHARGE IN CFS
DRAINAGE AREA IN SQ. MI.
DAM SAFETY PROGRAM
PMF ENVELOPE CURVES
FOR
PASSAIC RAHWAY & RARITAN BASINS
NAPEN-H
5 APR 78

1


Ryder Lake
SUSSEX
MORRIS


3
Tamarack Lake
Lake Gerard
Pequannock
Pequannock River
Peacock Brook
Canistear
MORRIS
SUSSEX

4

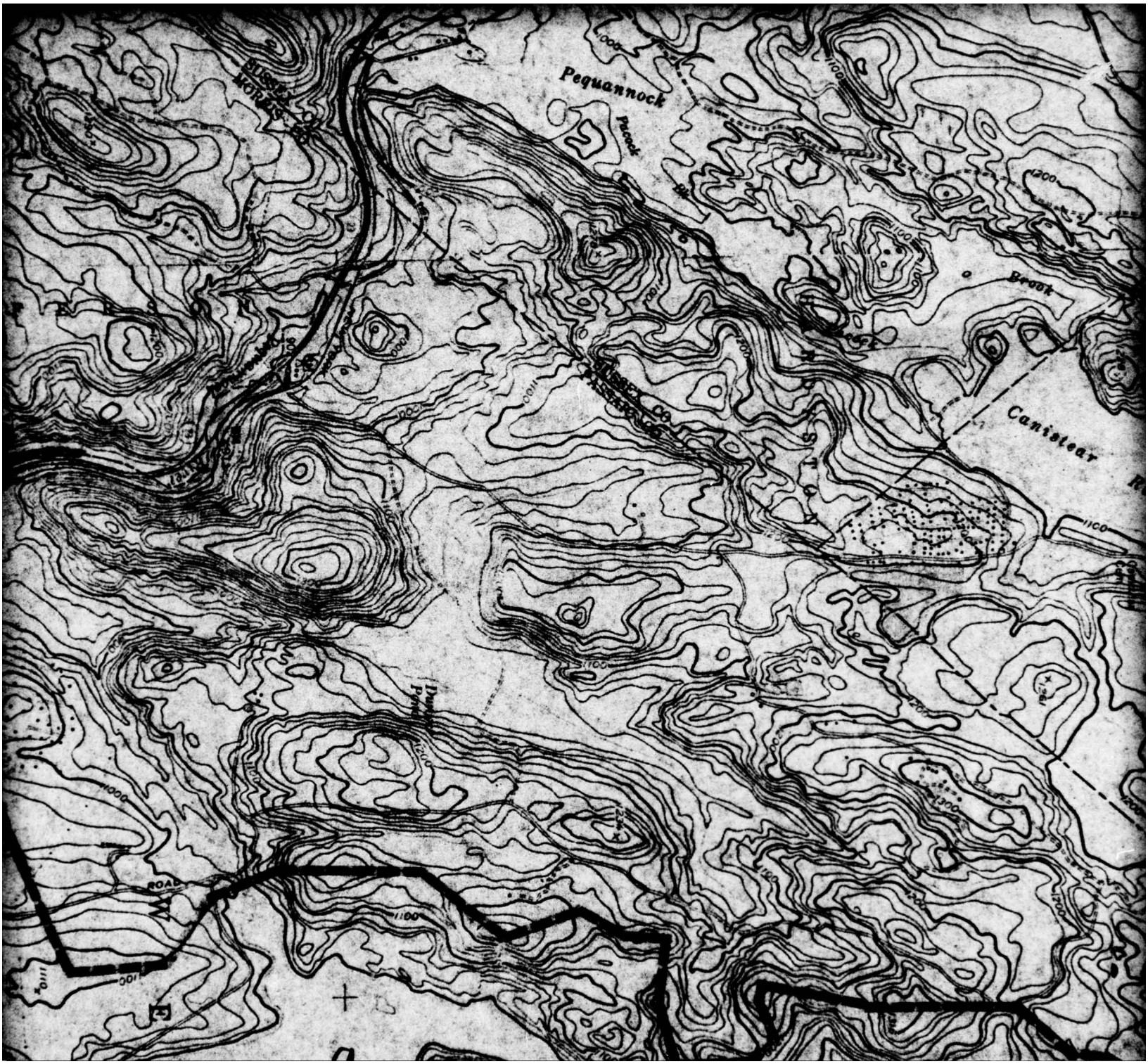
Silver Lake
Lake Wildwood
Mud Pond
River
Brook
Canisteer
Reser


5
Lake Wildwood
Mud Pond

6


PASSAIC CO.
MORRIS CO.
Oak Ridge
Pequannock
Trailer
Mosepac
Pond
Cozy
Lake
River
Valley
Pond
Green Pond
Green Pond
Pond
JEFFERSON MOUNTAIN
Jefferson
Pond
BM
RM
1078
Timber
Rock
Whapoon
Kitchell
Creek
Brook


Clinton
W E S T
Clinton
Greenwood Pond
Tallmans Pond
Wallace Pond
Schaffer Pond
Turner
Brook
River
WESTERN
PASSAIC CO
MORRIS CO
Old Ridge
Ramapo
Trailer
SUSQUEHANNA
ROAD
PARADISE
BM
1930
1838
778
1110


Pequannock
Brook
Canistear
ROAD


Marshall Pond
Cherry Ridge
Pequannock
Brook
Canistear Reservoir
VERNON
Canistear Reservoir
Pequannock
Brook
Canistear Reservoir
SUSSEX CO.
PASSAIC CO.
1200
1300
1100
1400


Highland
Lake
Cherry
Ridge
Brook
W

12

HEC-1 OUTPUT

OAK RIDGE RESERVOIR

```
OAKOUT1    16:11 MAR 19,'79

1**********
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  11 JAN 79
 **********
     1              A              OAK RIDGE RESERVOIR DAM
     2              A              INFLOW HYDROGRAPH
     3              A              N.J. DAM INSPECTION
     4              B    100       1        0        0        0        0        0        0        0        0
     5              B1     3
     6              K              1                                                  1
     7              K1   COMPUTE HYDROGRAPH
     8              M      1       1       27                        0.821
     9              P             22.1     102      113      123      133
    10              T                                                  1      .15
    11              W    6.18      0.4
    12              X      -2               1
    13              K      99
1                          PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                RUNOFF HYDROGRAPH AT          1
                                END OF NETWORK


1**********
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  11 JAN 79
 **********

 RUN  DATE: 79/03/19.
      TIME: 11.07.15.


                                OAK RIDGE RESERVOIR DAM
                                INFLOW HYDROGRAPH
                                N.J. DAM INSPECTION

                                      JOB SPECIFICATION
                  NQ       NHR      NMIN      IDAY       IHR      IMIN     METRC      IPLT      IPRT     NSTAN
                 100         1         0         0         0         0         0         0         0         0
                                     JOPER       NWT     LROPT     TRACE
                                         3         0         0         0
```

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

COMPUTE HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	27.00	0.00	27.00	.82	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.10	102.00	113.00	123.00	133.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.15	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 6.18 CP= .40 NTA= 0

RECESSION DATA

STRTQ= -2.00 QRCSN= 0.00 RTIOR= 1.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 6.55 AND R=11.53 INTERVALS

UNIT HYDROGRAPH 65 END-OF-PERIOD ORDINATES, LAG= 6.22 HOURS, CP= .40 VOL= 1.00

61.	229.	466.	730.	958.	1102.	1128.	1059.	971.	890.
816.	748.	686.	629.	577.	529.	485.	445.	408.	374.
343.	314.	288.	264.	242.	222.	204.	187.	171.	157.
144.	132.	121.	111.	102.	93.	86.	78.	72.	66.
60.	55.	51.	47.	43.	39.	36.	33.	30.	28.
25.	23.	21.	20.	18.	16.	15.	14.	13.	12.
11.	10.	9.	8.	8.					

0 END-OF-PERIOD *FLOW*

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	1.00	1	.01	0.00	.01	54.	1.03	3.00	51	0.00	0.00	0.00	13653.
1.01	2.00	2	.01	0.00	.01	54.	1.03	4.00	52	0.00	0.00	0.00	12544.
1.01	3.00	3	.01	0.00	.01	54.	1.03	5.00	53	0.00	0.00	0.00	11517.
1.01	4.00	4	.01	0.00	.01	54.	1.03	6.00	54	0.00	0.00	0.00	10569.
1.01	5.00	5	.01	0.00	.01	54.	1.03	7.00	55	0.00	0.00	0.00	9696.
1.01	6.00	6	.01	0.00	.01	54.	1.03	8.00	56	0.00	0.00	0.00	8895.
1.01	7.00	7	.03	0.00	.03	54.	1.03	9.00	57	0.00	0.00	0.00	8160.
1.01	8.00	8	.03	0.00	.03	54.	1.03	10.00	58	0.00	0.00	0.00	7487.
1.01	9.00	9	.03	0.00	.03	54.	1.03	11.00	59	0.00	0.00	0.00	6869.

1.01	10.00	10	.03	0.00	.03	54.	1.03	12.00	60	0.00	0.00	0.00	6303.
1.01	11.00	11	.03	0.00	.03	54.	1.03	13.00	61	0.00	0.00	0.00	5783.
1.01	12.00	12	.03	0.00	.03	54.	1.03	14.00	62	0.00	0.00	0.00	5307.
1.01	13.00	13	.15	0.00	.15	54.	1.03	15.00	63	0.00	0.00	0.00	4871.
1.01	14.00	14	.18	0.00	.18	54.	1.03	16.00	64	0.00	0.00	0.00	4470.
1.01	15.00	15	.23	0.00	.23	54.	1.03	17.00	65	0.00	0.00	0.00	4103.
1.01	16.00	16	.57	.26	.31	70.	1.03	18.00	66	0.00	0.00	0.00	3767.
1.01	17.00	17	.21	.06	.15	117.	1.03	19.00	67	0.00	0.00	0.00	3458.
1.01	18.00	18	.17	.02	.15	189.	1.03	20.00	68	0.00	0.00	0.00	3175.
1.01	19.00	19	.01	0.00	.01	274.	1.03	21.00	69	0.00	0.00	0.00	2916.
1.01	20.00	20	.01	0.00	.01	353.	1.03	22.00	70	0.00	0.00	0.00	2678.
1.01	21.00	21	.01	0.00	.01	408.	1.03	23.00	71	0.00	0.00	0.00	2460.
1.01	22.00	22	.01	0.00	.01	427.	1.04	0.00	72	0.00	0.00	0.00	2260.
1.01	23.00	23	.01	0.00	.01	413.	1.04	1.00	73	0.00	0.00	0.00	2077.
1.02	0.00	24	.01	0.00	.01	386.	1.04	2.00	74	0.00	0.00	0.00	1909.
1.02	1.00	25	.12	0.00	.12	359.	1.04	3.00	75	0.00	0.00	0.00	1755.
1.02	2.00	26	.12	0.00	.12	334.	1.04	4.00	76	0.00	0.00	0.00	1613.
1.02	3.00	27	.12	0.00	.12	310.	1.04	5.00	77	0.00	0.00	0.00	1484.
1.02	4.00	28	.12	0.00	.12	289.	1.04	6.00	78	0.00	0.00	0.00	1365.
1.02	5.00	29	.12	0.00	.12	270.	1.04	7.00	79	0.00	0.00	0.00	1256.
1.02	6.00	30	.12	0.00	.12	252.	1.04	8.00	80	0.00	0.00	0.00	1156.
1.02	7.00	31	.33	.18	.15	246.	1.04	9.00	81	0.00	0.00	0.00	1063.
1.02	8.00	32	.33	.18	.15	273.	1.04	10.00	82	0.00	0.00	0.00	979.
1.02	9.00	33	.33	.18	.15	344.	1.04	11.00	83	0.00	0.00	0.00	902.
1.02	10.00	34	.33	.18	.15	465.	1.04	12.00	84	0.00	0.00	0.00	831.
1.02	11.00	35	.33	.18	.15	628.	1.04	13.00	85	0.00	0.00	0.00	767.
1.02	12.00	36	.33	.18	.15	819.	1.04	14.00	86	0.00	0.00	0.00	707.
1.02	13.00	37	1.85	1.70	.15	1108.	1.04	15.00	87	0.00	0.00	0.00	653.
1.02	14.00	38	2.22	2.07	.15	1662.	1.04	16.00	88	0.00	0.00	0.00	603.
1.02	15.00	39	2.78	2.63	.15	2657.	1.04	17.00	89	0.00	0.00	0.00	558.
1.02	16.00	40	7.03	6.88	.15	4479.	1.04	18.00	90	0.00	0.00	0.00	516.
1.02	17.00	41	2.59	2.44	.15	7306.	1.04	19.00	91	0.00	0.00	0.00	477.
1.02	18.00	42	2.04	1.89	.15	10802.	1.04	20.00	92	0.00	0.00	0.00	442.
1.02	19.00	43	.18	.03	.15	14369.	1.04	21.00	93	0.00	0.00	0.00	410.
1.02	20.00	44	.18	.03	.15	17268.	1.04	22.00	94	0.00	0.00	0.00	380.
1.02	21.00	45	.18	.03	.15	19027.	1.04	23.00	95	0.00	0.00	0.00	353.
1.02	22.00	46	.18	.03	.15	19441.	1.05	0.00	96	0.00	0.00	0.00	327.
1.02	23.00	47	.18	.03	.15	18743.	1.05	1.00	97	0.00	0.00	0.00	303.
1.03	0.00	48	.18	.03	.15	17514.	1.05	2.00	98	0.00	0.00	0.00	281.
1.03	1.00	49	0.00	0.00	0.00	16152.	1.05	3.00	99	0.00	0.00	0.00	261.
1.03	2.00	50	0.00	0.00	0.00	14853.	1.05	4.00	100	0.00	0.00	0.00	243.
									SUM	24.13	19.23	4.91	338029.
										(613.)	(488.)	(125.)	(9571.92)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	19441.	17876.	11317.	4634.	337881.
CMS	550.	506.	320.	131.	9568.
INCHES		6.16	15.60	19.16	19.40
MM		156.43	396.14	486.65	492.80
AC-FT		8864.	22447.	27575.	27924.

THOUS CU M 10934. 27688. 34014. 34444.

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1

RUNOFF SUMMARY, AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES(SQUARE KILOMETERS)

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	19441.	17876.	11317.	4634.	27.00
		(550.50)	(506.18)	(320.46)	(131.23)	(69.93)

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 11 JAN 79
****

1

APPENDIX 4

REFERENCES

OAK RIDGE RESERVOIR

APPENDIX 4

REFERENCES

OAK RIDGE RESERVOIR DAM

1. Specification for the Raising of the Dam at Oak Ridge Reservoir, date unknown, estimate 1917.

2. .Letter to Dept. of Conservation and Development from Board of Street and Water Commissioners, Newark, New Jersey, dated 26 March 1917.

3. Letter to Dr. H.B. Kummel, State Geologist from C.C. Vermeule, Civil Engineer, dated 3 April 1917.

4. Inspection Report by J.E. Ganatt, dated 30 September 1968.

5. Drawings (5) giving plans, sections, contours, and profiles, by The East Jersey Water Company, dated between 14 July 1890 and July 1892.

6. Drawings (5) giving plans profiles, and sections by Board of Street and Water Commissioners Department of Water, Newark, New Jersey, dated 19 March 1917.

7. Brater, Ernest F. and Kings, Horace W. Handbook of Hydraulics 5th Edition, McGraw-Hill Book Company 1963.

8. Chow, Ven Te, Ph.D, Open Channel Hydraulics, McGraw-Hill Book Company, 1959.

9. United States Dept. of Agriculture, Soil Conservation Service SCS National Engineering Handbook Section 4 Hydrology NEH-Notice 4-102, August 1972.

10. United States Dept. of Agriculture, Soil Conservation Service, Somerset, N.J. Urban Hydrology for Small Watersheds, Technical Release No. 55, January 1975.

11. United States Dept. of Commerce Weather Bureau, April 1956 Hydrometeorological Report No. 33, Washington, D.C.

12. United States Dept. of Interior, Bureau of Reclamation Design of Small Dams, Second Edition 1973, Revised Print 1977.

13. Wolfe, P.E., 1977 The Geology and Landscapes of New Jersey, Crane, Russak & Company, Inc., New York, New York,351 pp.

14. Andrew L. Simon 1976, Practical Hydraulics, John Wiley & Sons, Inc.